DOCUMENT RESUME

ED 243 669 SE 044 400

AUTHOR	Cutcliffe, Stephen H., Comp.
TITLE	The Machine in the University: Sample Course Syllabi for the History of Technology and Technology Studies.
INSTITUTION	Lehigh Univ., Bethlehem, Pa.; Society for the History of Techology.
PUB DATE	Jun 83
NOTE	183p.; A publication of the Technology Studies and Education Committee in cooperation with the Science, Technology and Society Program at Lehigh University.
AVAILABLE FROM	Science, Technology and Society Program, 327 Maginnes Hall #9, Lehigh University, Bethlehem, PA 18015 ($7.50).
PUB TYPE	Reports - Descriptive (141) -- Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	*Course Descriptions; Course Objectives; Higher Education; *History Instruction; Industrialization; Public Policy; Sciences; *Technological Advancement; Technological Literacy; *Technology; *United States History; Western Civilization; *World History

ABSTRACT

Provided are 19 sample course syllabi typifying the broad range of courses taught in the field of the history of technology and technology studies. These syllabi are divided into three major sections: (1) world history, covering the history of technology in a western or world context over the period from earliest man and the era of classical antiquity to the present; (2) American history, including courses solely on the history of American technology; and (3) courses that concentrate on a particular historic theme or focus on a specific aspect of technology studies more broadly conceived, such as values questions or politics and technology. Each syllabus contains a statement of course goals, subjects covered, required and/or suggested readings and, in many cases, study and examination questions. While there is a certain amount of overlap among the topics and readings in the syllabi, there is also some unique aspect that makes each course stand out from the others, whether it be the level at which it is taught, the particular combination of length and choice of readings, or the major themes selected for attention. An appendix includes a list of 66 additional courses, each of which is briefly annotated. (JN)

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THE MACHINE IN THE UNIVERSITY:

SAMPLE COURSE SYLLABI FOR THE HISTORY OF TECHNOLOGY AND TECHNOLOGY STUDIES

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Compiled and Edited by Stephen H. Cutcliffe
and
The Technology Studies and Education Committee
for The Society for the History of Technology

in cooperation with The Lehigh University Science, Technology and Society Program

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June 1983

cover design by Robert Carlen
adapted from an original engraving
contained in the 1851 edition of
The Iconographic Encyclopedia of Science, Literature and Art
and reprinted in Johann G. Heck,
The Complete Encyclopedia of Illustration
(New York: Park Lane, 1979)

Copies of *The Machine in the University* are available from the Science, Technology and Society Program, 327 Maginnes Hall #9, Lehigh University, Bethlehem, PA 18015 at $7.50 each.

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INTRODUCTION

Although by no means previously unknown, the study of the history of technology has in the past two decades become the focus of attention of an increasing number of academic scholars. From its inception in 1958, however, the Society for the History of Technology (SHOT) has not only been interested in scholarly research, but also in the educational side of its discipline. As the field became soundly established and expanded in popularity, interest in matters related to the teaching of the history of technology increased to the point in the mid-1970s where SHOT established a formal standing committee to deal with educational issues of interest to members of the Society. This Technology Studies and Education (TS&E) Committee has as its purview general educational topics and activities as they relate to the history of technology, as well as to the broader field of technology studies, loosely encompassing such areas as the philosophy of technology and the social context of technology. The TS&E Committee has coordinated a number of programs at SHOT annual meetings and has sought in general ways to promote the educational side of the Society's interests. In the fall of 1981 in response to increased requests by newcomers to the field for information on teaching the history of technology, including appropriate topics and reading materials, as well as to a general interest among Society members in what other colleagues were teaching, the TS&E Committee embarked on a project to collect and publish a selected number of representative course syllabi in the field. This booklet is the culmination of that project.

Initially the Committee sent out a call for course syllabi in the history of technology and closely related areas of study. Seventy-five individuals and groups responded by sending course syllabi ranging from as little as one or two typed pages to those with over a hundred pages of supporting material. The wealth of ideas and good material was extensive and made it difficult for the Committee to screen and to determine what should be included for reproduction. Ultimately, the Committee decided to include a range of course materials that, in its view, would be helpful to as many prospective instructors as possible in establishing new, or expanding their own, courses. The Committee recognized a large number of excellent courses, but because of the briefness of some of the outlines included, or the specialized focus of others, felt they would be of less widespread interest than the ones selected for inclusion. However, to insure that none of these materials were lost to those who might well make use of them, a brief annotated list of individuals and courses, the syllabi for which were not reproduced in their entirety, is included as an appendix to this volume. Presumably each of these individuals would be willing to share his or her ideas and materials with those desirous of further information. Contact should be made directly with the individual, rather than through the TS&E Committee.

The nineteen courses as taught by seventeen individuals or pairs of individuals reproduced in the booklet break down into three major categories. In the first section are those courses which cover the history of technology in a Western or world context over the period from earliest man and the era of classical antiquity to the present. A second section includes courses solely on the history of American technology. The third section includes those courses that concentrate on a particular historic theme or focus on a specific aspect of technology studies more broadly conceived, for example, values questions or politics and technology.

In selecting these courses, the TS&E Committee sought to include those that seemed to cover most of the major topics and themes in the history of technology in the hopes that this would help to guide newcomers to the field. At the same time, the Committee attempted to select courses that included good suggestions for readings, both for students and for instructors. Finding good texts for students in the history of technology is difficult, although admittedly easier in recent years than in the past. Similarly, it is important to guide new instructors to the most important books in the field, thereby helping them to avoid the confusion of wading through large numbers of specialized monographs and an extensive journal literature, much of which is inappropriate for classroom use.

For those who are already well versed in the field, just seeing what other colleagues cover by way of topics and include for readings can be helpful in assessing and updating their own teaching. The committee also hoped that those courses that included sample study and exam questions or term paper projects would prove particularly useful. The study and exam questions in particular point out, in a way that a list of readings cannot do nearly as well, exactly what it is that the instructor in a course deems important and hopes that the students have absorbed.

A brief word on the range of courses chosen for inclusion is in order. While there is a certain amount of occasional overlap among topics and readings, there is also something that makes each course stand out from the others, whether it be the level at which it is taught, the particular combination of length and choice of readings, or the major themes selected for attention. Richard Hirsch and James Schaub both offer fairly standard year-long courses divided into quarters and semesters respectively. Each of the courses highlights major topics in the history of technology and suggests the range of materials that are possible for use as texts. W. David Lewis offers a unique combination of the history of technology and the classical writers through his year-long honors sequence. Howard Segal shows that much the same material can be covered in a single semester in which he emphasizes major technological themes, while Jeffrey Sturchio covers much the same ground in the first part of a two-semester sequence in which the second half of the sequence focuses primarily on the American experience.

In contrast to this first group, a number of instructors choose to concentrate only on the history of American technology. Offerings range from James Williams's one-semester course at the community college level to Darwin Stapleton's graduate level seminar which highlights the major themes in both the history of technology and of science and touches upon the inter-relationships between the two. As with technology in the context of Western civilization, the history of technology in America can be taught as a one-semester course as done by John Staudenmaier, who concentrates on the concept of an identifiable American "style" of technology, or as a year-long sequence as taught by Merritt Roe Smith and David Noble, who emphasize the social, economic, and intellectual setting, as well as the internal history of the technology itself. Taking a still different approach, technology can be explored from the perspective of material culture as is done by Patrick Malone in his two-semester survey.

When we realize the range of possible topics in the history of technology, it is not surprising to find that there are a number of courses that focus on a particular theme. Typical of such thematic treatments are Daryl Hafter's course on the role of women in technological history and Mark Rose's offerings on the history of the American automobile and the relationship of technology to American cities. Allan Gianinny takes an intriguing biographical approach in his course on Thomas Jefferson's interests in science and technology. Similar to these historians who take a focused look at technology in their course work are those instructors who look at contemporary societal questions as they relate to technology. Of those who view technology as a social process and are therefore interested in the human values questions surrounding it, the courses offered by Martin Curd, Steven Goldman, and Carl Barus and Patricia Springborg are particularly interesting. Likewise the attention to the political arena provided by Lynton Caldwell and Robert Bartlett's course is central to understanding the relationships between technology and contemporary society. While numerous other thematic topics might well have been chosen --technology and literature, bioethics, etc.-- the courses selected for inclusion in this section provide a reasonable suggestion of the spectrum of subject material available for possible inclusion in course work.

As with course topics, there is a wide range of supporting material that can be used for assigned readings in such courses. The TS&E Committee tried to include courses which offered a variety of textual suggestions, both for assigned readings as well as for supplemental suggestions. The choice of readings is always tenuous at best. What works well for one class or one instructor does not always do the same for the next course. Thus, while some text assignments are found in several of the courses, many others will be appropriate only to one instructor's approach and hence only to his or her own course. The popularity and availability of texts, which are not always directly related, vary over time, but an attempt was made to include courses, and hence textbook assignments, that were taught recently. Thus, most of the course versions included in this booklet were taught during the academic years 1980-81 and 1981-82. This means that more recent publications might well be added to, or supplemented for, existing texts in some of these courses.

The history of technology is by no means a static affair; by its very nature, therefore, this guide will be partially outdated as soon as it is available. This is not to suggest, however, that there are not some enduring themes in the history of technology that will find their way to the center of good courses in the field --themes such as industrialization, the processes of invention and innovation, the concept of systems, the notions of technology as knowledge and as social force, and technology transfer. Similarly, there are enduring books and articles in the field of which any newcomer must eventually become aware. A brief compilation of course syllabi such as this one can provide clues to all of these, but as in most fields there exist several guides and bibliographies that will be of help. Of particular use are Eugene Ferguson's standard *Bibliography of the History of Technology* (Cambridge, MA: MIT, 1968); Marc Rothenberg's *The History of Science and Technology in the United States: A Critical and Selective Bibliography* (New York: Garland, 1982); Paul Durbin's *A Guide to the Culture of Science, Technology, and Medicine* (New York: The Free Press, 1979); and Stephen Cutcliffe, Judith Mistichelli, and Christine Roysdon's *Technology and Values in American Civilization: A Guide to Information Sources* (Detroit: Gale Research Co., 1980). These last two cover the broader field of technology studies as well as the history of technology. Finally, the Society for the History of Technology's annual bibliography published in the April issue of its journal *Technology and Culture* should be consulted for continually updated bibliographical information.

In compiling a resource guide a number of debts are inevitably incurred. First and most obvious are the thanks due to the individual instructors who submitted their course materials for inclusion. Without them, the possibility of such a project would of course be moot. Likewise, thanks are due to the members of the Technology Studies and Education Committee who helped to plan and coordinate the project and to screen and select the syllabi for inclusion. Lastly, in a project that grew in scope and complexity far beyond that originally conceived, despite the availability of advanced technology in the form of a word processor, the assistance of the Lehigh University Science, Technology and Society Program was invaluable. Mary Jo Carlen and especially Mary Ann Orsinger were of particular help in seeing the project through to completion through their efforts at coordinating mailing lists, the searching out of publication data for wayward text references, and the constant typing and retyping of the syllabi themselves. Their feeling for details and the worth of the project combined with a sense of humor made what would otherwise have been a tedious chore only to be endured, into instead a rewarding and enjoyable task. My appreciation to them for their hard work is therefore that of utmost sincerity and profound admiration. A special appreciation is also due to Robert Carlen who took time out from a hectic work schedule to design and have printed the cover for the booklet. Finally, thanks go to Susan Byatt who also helped to unearth numerous publication references for readings included in the course materials. Hopefully no errors have crept into this collection of material, but if so, I must bear responsbility for them and would appreciate anyone bringing them to my attention.

Stephen H. Cutcliffe, Chairperson
Technology Studies and Education Committee
Society for the History of Technology

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SECTION I.

TECHNOLOGY IN WORLD HISTORY

HISTORY OF TECHNOLOGY
FROM PREHISTORY TO THE INDUSTRIAL REVOLUTION

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Virginia Polytechnic Institute and State University
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Modern society can be characterized by technological achievements and their ill-considered side effects. These include powerful machines, grandiose architectural masterpieces, and efficient factories on the one hand and environmental pollution, energy shortages, and labor unrest on the other. But these elements of society are really not such recent developments. Hundreds of years ago, societies that produced new inventions and engineering techniques also faced challenges concerning how to use them most effectively. Like us today, our ancestors were not always successful in meeting these challenges.

In this course, we will examine the history of technology from prehistoric times to the onset of the industrial revolution in the 17th century. Besides looking at technological accomplishments, we will also consider their impact on different societies. Since many responses to technology have not changed much since ancient times, a study of the development of early technologies may give us insights into recent achievements and their effects on modern life.

This course, History 4211, is the first of a three-quarter sequence in history of technology. In the winter, we offer History of Technology 4212, which concerns the history of the industrial revolution from 1700 to 1900. The spring course, History of Technology 4213, deals with the history of modern technology in America from 1900 through 1982.

COURSE REQUIREMENTS:

Attendance of classes, one mid-term examination, and a final examination. Grades will be assigned on the basis of the following approximate formula and a modified bell curve:

Mid-term exam:	30%
Paper:	30%
Final Paper:	40%

Paper Assignment

I want you to choose an invention or technological process and discuss it by answering the following questions:

1) Why and how was it invented? What need was there for the innovation? In other words, what was the background of this invention?

2) What did the invention do? Describe the innovation in enough detail so that I know you understand how it works. Why was it an improvement over what came before it?

3) What impact did the innovation have on society and on other technologies? How did it change people's lives, and how did it affect the development of other technologies?

The purpose of this paper is to give you more experience with concepts and themes in the history of technology. Your case study should provide insight into the nature of technological innovation and its impact on society.

Guidelines:

1) The paper should be written on an innovation made during the time period we are studying in the course.

2) Do not write on an innovation that I have lectured about in class. I want you to study something new. See me for approval before you begin work on the paper.

3) Make sure your paper is focused on one development only. You may write about the early plow, for example, but do not write about early agriculture. You may need to write about aspects of these subjects, but I want a narrowly focused paper on a single innovation.

4) List the sources of your information in a bibliography. Supply the Virginia Tech call numbers for the books you used.

5) The paper should be 3-4 typed pages long and double spaced. If it is longer than 4 pages, I will deduct 3 points for each page.

6) Include pictures if they will help in describing the innovation. They will not be counted as pages, however, for the 3-4 page limit.

7) Proofread your paper to make sure you did not make spelling or typing errors. For every error more than 4, I will deduct 1/2 point.

8) Make one xerox copy of the paper, which I will keep. Just staple the pages together. There is no need for fancy covers for the original or copy.

Advice:

A. Remember that this should be a history paper that discusses the factors that caused an innovation to be made and the impact it had on society. Do not write an engineering paper that is exclusively descriptive. It should be mostly analytical instead.

B. If you have trouble selecting a topic, think about the most important innovations made in your major field of study. Look for historical comments in your textbooks that might lead you to interesting topics.

Some people in the past have found it difficult to find topics in the history of ancient technology. Here are a few suggestions:

Greek locks
Medieval paper production
The crank
The astrolabe
Eyeglasses
The compass

The sternpost rudder
The sail
The flying buttress
The catapult
etc.

C. Start work on the paper as early as you can. Those people who wait until the last minute will have difficulty finding sources in the library.

D. Have fun with this paper!

REQUIRED READINGS:

J. Gimpel, *The Medieval Machine* (NY: Penguin, 1976). Other short articles listed below are available in duplicated form.

TENTATIVE SCHEDULE:

(This quarter-length course meets bi-weekly for a total of 21 sessions, Editor)

1. Course Introduction

ANCIENT TECHNOLOGY

2. Prehistoric Technology and the Agricultural Revolution
   S. L. Washburn, "Tools and Human Evolution," *Scientific American* 203 (Sept. 1960) 62-75.
   R. J. Forbes, *The Conquest of Nature: Technology and Its Consequences* (NY: Praeger, 1968), pp. 19-33.
   P. F. Drucker, "The First Technological Revolution and Its Lessons," *Technology and Culture* 7 (Spring 1966): 143-51.

3. Technology in the River Valley Civilizations
   N. Smith, "Ancient Irrigation," in *Man and Water* (London: Peter Davies, 1976), pp. 3-18.

4. Craft Technology in Antiquity
   V. G. Childe, "The Neolithic Revolution," in *Man Makes Himself* (New York: New American Library, 1951), pp. 75-81.

5. Craft Technology, continued, and Film, "The Hidden Structure."
   R. Maddin, J. D. Muhly, and T. S. Wheeler, "How the Iron Age Began," *Scientific American* 237 (Oct. 1977): 122-32.

6. Technology in Classical Greece and Rome
   R. J. Forbes, "Greeks and Romans," in *Man the Maker* (NY: Henry Schuman, 1950), pp. 60-88.
   J. G. Landels, "Power and Energy Sources," Ch. 1 in *Engineering in the Ancient World* (London: Chatto and Windus, 1978), pp. 9-31.

7. Open

8. Technology in Classical Greece and Rome, continued
Norman Smith, "Roman Hydraulic Technology," Scientific American 238 (May 1978): 154-61.
V. Foley and W. Soedel, "Ancient Oared Warships," Scientific American 244 (April 1981): 148-62.

9. The "Failure" of Ancient Technology

10. MID-TERM EXAMINATION

MEDIEVAL TECHNOLOGY

11. The Energy Revolution
Gimpel, Chs 1,4.

12. The Agricultural Revolution
Gimpel, Chs. 2,3.

13. Military Technology PAPER DUE TODAY
P. Young, "The Dark and Middle Ages," in The Machinery of War (London: Hart Davis, 1973), pp. 29-41, 54-57.

14. Clocks and Culture
Gimpel, Ch. 7.

15. The Printing Press
D. S. L. Cardwell, "The Printing Press," in Turning Points in Western Technology (New York: Science History, 1972), pp. 19-29.

16. The "Success" of Medieval Technology
L. Casson, "Godliness and Work," Science 81 2 (Sept. 1981): 136-43.

ORIGINS OF MODERN TECHNOLOGY

17. A New Intellectual Framework for Technology
Gimpel, Chs. 8,9, and epilog.

18. The Mechanical Philosophy and Discovery of the Atmosphere
Cardwell, "The Scientific Revolution and the Progress of Technology," in Turning Points, pp. 46-59.

19. Early Steam Technology
__________, "Newcomen and his Fire-Engine," in Ibid., pp. 66-72.

20. Conclusion

21. FINAL EXAMINATION (No changes except with Dean's permission).

Questions to Guide Readings

Washburn
1. How have tools affected the evolution of humankind?
2. What is the significance of bipedalism?
3. What was the importance of "self-domestication"?

Drucker
1. Why was the age of irrigation civilization an age of technological innovation?
2. When and why did the individual "emerge"?

Smith
1. Describe the irrigation techniques used in Mesopotamia.
2. What were some technological consequences of irrigation?
3. How labor intensive were irrigation schemes?

Childe
1. Describe some neolithic industries.
2. What devices were used for textile making?

Mardin
1. How, why, and when did iron replace bronze?
2. Describe the steps in making iron and steel? What are the advantages and disadvantages of steel?
3. What is quenching?

Forbes
1. How much and what kind of machinery existed in classical societies?
2. How extensively were power machines used? Why?
3. Describe Roman communications and transportation technologies?
4. What is a war engine?

Landels
1. What kinds of power sources were used in classical antiquity for different jobs?
2. Describe different types of water wheels and their advantages.
3. How much were wind and steam sources used? Why?

Smith
1. Why did the Romans build aqueducts?
2. What special techniques and materials did they use?
3. How sophisticated was Roman hydraulic technology? Did others emulate it?

Foley
1. Describe the evolution of the trireme.
2. What were some of the sophisticated design techniques used by the Greeks in building ships?
3. What scientific principles did the Greeks consciously employ?

Young Article
1. What happened to the military arts after the fall of the Roman empire?
2. What was the answer to the power of heavy cavalry?
3. What was the significance of the Swiss Pike Phalanx?
4. Describe offensive and defensive tactics of siegecraft.

Cardwell Excerpt: "The Printing Press"

1. What were the distinct stages of Gutenberg's "solution"?
2. What two inventions still determine the course of daily life?
3. Why is the perpetual motion machine considered important in the history of technology?

Casson Article

1. How much did the Romans and Greeks exploit mechanical power?
2. How detrimental was slavery to technological innovation in the Roman Era? In the Middle Ages?
3. What prejudices did the Greeks and Romans have concerning work?
4. What impact did Christianity have on technological innovation?

Cardwell Excerpt: "The Scientific Revolution"

1. What is meant by the "century of genius"? What occurred during this century?
2. How did a philosophy of nature affect scientific developments? Describe the philosophy.
3. What is meant by the "discovery of the atmosphere"?

Cardwell Excerpt: "Newcomen and the Fire Engine"

1. Why would Bacon have been delighted with Newcomen's invention?
2. What are the main features of the Newcomen engine?
3. What were the motivations of Savery and Newcomen in inventing their steam engines?

Gimpel Book

1. What were some of the major features accompanying the first industrial revolution? What makes them so remarkable?
2. Why were monasteries significant in the history of medieval technology?
3. What are the contents of the Domesday report?
4. What does the use of tidal mills represent?
5. What impact did the climate have on medieval agriculture?
6. What allowed horses to pull 6,400 kg?
7. What was the symbiotic relationship between horses and the medieval agricultural system?
8. What were the consequences of the heavy plow?
9. Describe the medieval diet.
10. Why was stone quarrying the most important mining industry in medieval Europe?
11. What was the significance of waterpower to the iron industry?
12. How and why did European industrialism play havoc on the environment? Provide examples.
13. Why were royal forests created?
14. What antipollution measures were taken in the Middle Ages?
15. Why did medieval society believe in progress?
16. What were the consequences of clocks striking equinoctial hours?
17. What important step did Charles V take?
18. What did the "rational outlook on life" refer to?
19. What important contributions did the Arabs make to western science?
20. What did Roger Bacon do for experimental science?
21. What effects, positive and negative, did the Black Death have?
22. What comparisons does Gimpel make between the Middle Ages and recent history?

Mid-term Examination Information

You will be asked to write an essay on one of the following three essay questions. At the time of the test, I will tell you which one to write on. To prepare for it, you may want to make outlines of your arguments and fill them in with details and examples from your readings and class notes. However, you may not use the outline during the exam. It is a closed book text. The essay will be worth 30% of the test grade. There will also be a short answer section and a multiple choice section on the exam.

Possible Essay Questions

I. Peter Drucker writes in his article, "The First Technological Revolution and Its Lessons," that if an educated man of the First Technological Revolution were tranported magically to the present time, he would be able to cope with most aspects of modern civilization. Explain what Drucker means by the "First Technological Revolution," and explain why his assertion might be true. Give specific examples relating to social, economic, and various technological systems that were developed by 1000 B.C. and which are still common today.

II. Describe two agricultural innovations used by each of the following people:

a) Prehistoric man (before 5000 B.C.)
b) The Egyptian and Mesopotamian peoples

Analyze the importance of each of these innovations on the social development of their civilizations. In other words, what new social structures evolved as a result of these technological developments?

III. Three major ancient civilizations that we have discussed are those of the Egyptians, Greeks, and Romans. Each one had distinctive technologies that were developed as a result of different forces and were used for different purposes. In this essay, I want you to

a) Analyze the different reasons for the development of the technology in each civilization. In other words, how did the technology develop as it did, and what were the primary goals of the people who developed the technology.
b) Give one major example of each civilization's technology, and describe why and how it was developed. What were their uses?

For all of these essays, be sure to provide specific examples. You will be penalized for general, unsubstantiated claims.

Mid-Term Examination

I. Multiple Choice: In the following multiple choice questions, there are one or two correct answers. Circle the correct answer(s) and write it (them) on your answer sheet. Parts I and II of this exam are worth 70 points.

1. Which of the following names are/is associated with Roman water delivery systems? A) Djer; B) Heron (or Hero); [✓ C] Frontinus; [✓ D] Aqua Appia; E) Aquamarine.

2. Hammurabi's code was important historically because: A) It was a set of laws concerning irrigation in ancient Egypt; B) It provided instructions for building pyramids; [✓ C] It was the earliest known written legal framework; D) It instructed craftsmen how to build kilns and potter's wheels; E) It was the earliest known method of signaling over long distances.

3. Activities known to have occurred in the Fertile Crescent included: A) Greek temple building; [✓ B] Neolithic stockbreeding and farming; C) Inca temple building; D) Mesopotamian cultivation of the Nile River; E) Production of textiles in factories.

4. Ancient textile manufacturing was associated with which of the following? A) It used spinning wheels; B) It led quickly to mass production; C) It used expensive equipment comparable to that employed in pottery making; [✓ D] It was a cottage industry; E) None.

5. Compared to Roman engineers, Greek engineers were generally considered A) more talented; B) equally talented; [✓ C] less talented; D) too weak physically; E) more concerned with making money.

6. The form of steam engine invented by a Greek A) could have been a practical power source; B) was more typical of Roman technological innovations; [✓ C] was only an elegant plaything; D) led directly to Savery's work on another steam engine in the 1600s; E) was useful in developing London's water system in the 1800s.

7. Among the special techniques or devices used in Roman hydraulic technology was/were: A) the aqua appia; [✓ B] the chain of pots; C) the shaduf; D) the steam pump; [✓ E] the siphon.

8. The nucleus was A) part of a Greek temple; B) a war "engine"; [✓ C] part of a Roman road; D) an architectural device used by the Romans and Greeks; E) a combination of protons and neurons, as hypothesized by the ancient Greek inventor of atomic theory, Democritus.

9. Among the steps in making pottery was/were A) collating; B) fulling; C) carding [✓ D] forming; E) none.

10. Techniques used to make iron harder included A) bronzing; B) forging; [✓ C] carburizing; D) spinning; [✓ E] quenching.

11. Among the Greeks' inventions was/were A) concrete; B) the semi-circular arch; [✓ C] the trireme; D) the kiln; E) the ziggurat.

12. The "failure" of ancient technology had many causes, among which was/were: A) the abolition of mining by Romans; [✓ B)] the rise of Christianity; [✓ C)] little concern for the environment; D) the decline of Christianity; E) no knowldge of exploiting mechanical power for industrial uses.

13. People performing work in technology and science: A) share the same goals; B) have always employed similar quantitative methods; C) have interacted constantly throughout history; D) have always been well educated in schools; [✓ E)] none.

II. Fill-ins. In the following sentences, missing words are represented by blanks. On the answer sheet, write your precise and concise answers that correspond to these blanks. Except for 17, all all can be answered in one or two words. (Correct answers are typed in parentheses, Editor.)

14. Without man evolving into a (bipedal) animal, it is unlikely he would have become a maker of (tools (or technology))

15. Besides basin and perennial irrigation, two other irrigation techniques existed in the ancient world for more specialized situations. They were known as (wadi) and (terrace) irrigation.

16. Neolithic (pottery) making had great significance for human thought and for the beginning of science.

17. Bronze was sometimes a better material to work with than "bloomery" iron for several reasons. One is (harder; higher tensile strength; melts at lower temperatures; suited to casting).

18. Greek scientists who had great capacity for developing machinery included (Hero (or Heron)) and (Archimedes (or Ctesibius)).

19. The definition of "technology" generally includes three components. They are (machines (hardware)), (organization), and (knowledge).

20. The cooking of food led to several other technologies. Two of them were (pottery) and (metallurgy).

21. (Imhotep) was the first engineer known by name to history. (Joser) was his king for whom a pyramid was constructed.

22. The Egyptian pharoh found that knowledge of when the Nile floods would arrive gave him extra power in governing his people. Two technical devices that provided him with this knowledge were (Nilometer) and (calendar).

23. An example of a composite tool is the (sickle, hammer, spear, axe, etc.).

III. Essay (30 points). Be sure to provide specific examples and a complete analysis, not just a recitation of unrelated facts. (For possible questions see mid-term examination information, Editor)

Final Examination Information

You will be asked to write an essay on one of the following essay questions. At the time of the test, I will tell you which one to write on. To prepare for it, you may make outlines of your arguments and fill them in with details and examples from your readings and class notes. However, you may not use the outline during the exam. It is a closed book test. The essay will be worth between 40% and 60% of the test grade. There will also be a multiple choice section on the exam and some short answer questions.

Possible Essay Questions

I. The subtitle of Jean Gimpel's book, The Medieval Machine, is "The Industrial Revolution of the Middle Ages." In this essay, I want you to justify Gimpel's thesis that an Industrial Revolution did indeed occur during the middle ages. To write the essay, consider first the major changes that occurred between about 400 AD to 1715 AD. Then demonstrate how these changes led to a new technological order based on machines and processes that would relieve man's burden and increase his standard of living. Be sure to use specific examples from class notes, readings, and outside research.

II. Lewis Mumford characterizes the period of technology between roughly 100 AD and 1700/50 AD as a "wood and water" complex. In other words, wood and water were the primary materials used in many forms for western technology in this period. While I think that this description is generally correct, what I would like you to do is to attack this generalization. That is, write an essay in which you argue that Mumford's "wood and water" generalization does not hold. Use specific examples of machines or processes that support your argument.

III. An historian of technology recently wrote:

> The machines of the middle ages led to a "victory of the human spirit." They helped reduce mankind's drudgery so that people could use leisure time for more philosophical pursuits. Other machines did not necessarily reduce the amount of work people performed, but they nevertheless had a significant impact on the way increasing numbers of people thought about their natural environment.

In this essay, I want you to substantiate this assertion. Essentially, the statement can be broken down into two parts: one concerning labor saving machines, and the other concerning machines that affected the way people thought. Describe important examples of both these machines and show how they had an impact on people's lives. For the second type of machines, give specific examples of how they altered the way people arranged their lives and contemplated their natural surroundings.

For all these essays, be sure to provide specific examples. You will be penalized for general, unsubstantiated claims.

Final Examination

I. Multiple Choice: In the following multiple choice questions, there are one or two correct answers. Circle the correct answer(s) and write it (them) on your answer sheet.

1. Technology in the middle ages can be characterized by which of the following statements? A) There was a climate of opinion that rejected the use of power machines; [✓ B] Investment capital for industrial endeavors was raised more efficiently than in ancient times; [✓ C] Workmen's wages tended to increase during much of the middle ages; D) Windmills exploited water power extensively; E) There was little continuity between developments in medieval technology and modern (17th and 18th century) technology.

2. The development of the Newcomen steam engine (1712) was affected by which of the following? A) The abrupt and unexpected failure of over half the water wheels in England during a draught; B) The rediscovery of ancient Greek classical works on technology; [✓ C] The existence and publicity surrounding the "Miner's Friend." D) The need to pump water from silver mines; E) The introduction of steam locomotives.

3. The technological supremacy of the west over the east (Byzantium) can be explained partly by A) the east's supremacy in commerce, political stability, and level of education; B) the west's leadership in science; [✓ C] repeated invasions of the west by outsiders; D) the lack of typewriters in the east and the slow spread of learning; [✓ E] the western victory of Christianity over paganism.

4. Which of the following have something to do with waterwheels? A) Archimedes; B) Buccalentus; [✓ C] Vitruvius; D) Norsius; [✓ E] tidal mills.

5. The use of inorganic sources of energy in the middle ages A) led farmers away from the use of horses; B) resulted partly from the success of alchemists to improve energy outputs of fuels; C) became widespread in the middle eastern countries of Islam and Byzantium; [✓ D] contributed to the attitude that the use of machines was a good thing; E) encouraged the transition to coal and oil as primary fuel sources.

6. The agricultural revolution of the middle ages can be described by which of the following statements? [✓ A] The revolution was affected by a warmer and drier climate between about 750 and 1200 A.D. B) New plows were introduced to till the dry soil of the Mediterranean lands; C) New collars were introduced that enabled oxen to perform more work; D) The four-field system of crop rotation was introduced; E) Waterwheels were used extensively for irrigation purposes.

7. The new plow of the middle ages [✓ A] led to a more communal behavior by peasants; B) was made entirely of hard, flexible wood; C) made it possible for the first time to use light, dry soil for agriculture; D) was preferably pulled by oxen; [✓ E] changed the shapes of fields.

8. The origins of experimental science in the 13th century has been associated with A) Edward of Thierry; [✓ B)] Roger Bacon; C) Francis Bacon; D) Francis the Mule; E) Euclid.

9. The discovery of the atmosphere had several consequences, among which was (were): [✓ A)] an emerging science of meteorology; [✓ B)] aeronautical studies; C) invention of printing; D) invention of water pumps; E) coal mining in England.

10. The Newcomen fire engine was successful because A) it put out accidental fires in mines; [✓ B)] it had a separate boiler and cylinder; C) it was as safe as the Savery machines but was much cheaper to build; D) it could be and was used inside coal mines; E) its efficiency was improved by the scientific engineer, Galileo.

II. Fill-ins. In the following sentences, missing words are represented by blanks. On the answer sheet, write your precise and concise answers that correspond to these blanks. Most can be answered in a few words. (Correct answers are typed in parentheses, Editor.)

11. At the level of the common man, anthropocentric Christianity made it possible to do what? (Exploit natural resources; mine).

12. Compared to Roman times, the state of military arts in Europe in the early middle ages was (backwards; undisciplined). (Shock, armored) weapons were more useful than missiles. The first sign of change was instigated by (Charlemagne), the Frankish ruler, in about 800 A.D.

13. Gutenberg was successful in designing a printing press because of his ability to solve two technical problems. What were they?
(Finding a way to make stamps of equal length).
(Finding a way to make stamps of equal thickness).

14. Two examples of technologies that the ancient Greeks and Romans knew about but did not exploit were (wind power) and (water power, or (steam (turbine) power).

15. The earliest known national anti-pollution laws were passed in (England) in the late 14th century concerning pollution of the (water) and (air).

16. According to Gimpel's comparison of trends in the middle ages and in recent history, the United States is currently in an era of (maturity (steady state) and will soon enter an era of (decline).

17. Name one person who designed pendulum clocks in the 17th century. (Galileo (or Huygens)).

18. How did a famous historian categorize the medieval diet? ("full of beans").

19. What did another historian call "the key machine of the modern industrial age"? (the clock).

20. How did the Black Death improve the standard of living? (By adding to the wealth of those who survived through inheritance; reduced overcrowding.)

III. Essay
(For possible questions, see final examination information, Editor.)

HISTORY OF TECHNOLOGY 4212
THE INDUSTRIAL REVOLUTION

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During the period from 1700 to 1900 western civilization became characterized by the emergence of many novel technologies, such as powerful engines, rapid communications and transport systems, and towering architectural masterpieces. The period spans what is known as the Industrial Revolution, which began in Great Britain in the 1700s and which spread to the United States and elsewhere in the 1800s. In this course, we will examine the causes, manifestations, and consequences of the Industrial Revolution in the western world. We will focus on some of the major technological innovations and see how they influenced the evolution of other technologies and the people who used them. In studying this history, we will not accept technology uncritically. Rather, we will examine it to learn how it has acted as a powerful force in changing society.

This course is the second of a three-quarter sequence in history of technology. In the fall, we offer History of Technology 4211, which concerns the history of ancient and medieval technology from prehistoric times to 1700. The spring course, History of Technology 4213, deals with the history of modern technology from 1900 through 1982.

COURSE REQUIREMENTS: (See syllabus for History 4211 including paper assignment, Editor.)

REQUIRED READINGS:

C. Vialls, *Coalbrookdale and the Iron Revolution* (Cambridge: Cambridge University Press, 1980).
G. E. Davidson, *Beehives of Invention* (Washington, D.C.: National Park Service, 1973).
Other short articles listed below are available in duplicated form. The required readings are listed after the title of each lecture.

Tentative Schedule
(This quarter-length course meets bi-weekly for a total of 21 sessions, Editor.)
1. Course Introduction

The Industrial Revolution

2. The Agricultural Background to the Industrial Revolution in England.
   E. R. Chamberlin, "Changes in English Agriculture," in *The Awakening Giant: Britain in the Industrial Revolution* (London: Batsford, 1976), pp. 40-44.
   Peter Mathias, "Landownership and Change in Rural Society," in *The First Industrial Nation* (NY: Scribners, 1969), pp. 59-82.

3. The Steam Engine
Eugene S. Ferguson, "The Origins of the Steam Engine," *Scientific American* 210 (Jan. 1964): 98-107.

4. The Steam Engine, continued
Letter from Mathew Boulton to Erasmus Darwin about the Watt engine, 4 January 1790, in Jennifer Tann, ed., *The Selected Papers of Boulton and Watt, Vol. 1, The Engine Partnership, 1775-1825* (Cambridge, MA: MIT Press, 1981), pp. 72-74.

5. The Textile Industry and Factory System
D. S. L. Cardwell, "The Origins of Modern Technology," and "Arkwright and his Contemporaries," in *Turning Points in Western Technology* (New York: Science History, 1972), pp. 73-84, 94-101; and "Child Labor in Factories and Mines," in J. Bowditch and C. Ramsland eds. *Voices of The Industrial Revolution* (Ann Arbor: University of Michigan Press, 1968), pp. 82-90.

6. Coal, Iron, & Steel
Vialls book, and W. David Lewis, "The Advent of Cheap Steel," in *Iron & Steel in America* (Greenville, DE: Hagley Museum, 1976), pp. 35-41.

7. Revolution in Transportaion: Canals and Steamboats
Francis T. Evans, "Roads, Railways, and Canals," *Technology and Culture* 22 (January 1981): 1-34.
Daniel R. Headrick, "Secret Gunboats of East India," in *The Tools of Empire* (NY: Oxford, 1981), pp. 17-42.

8. Revolution in Transportaion: Steam Locomotive
Daniel J. Boorstin, "Getting There First," in *The Americans: The National Experience* (NY: Vintage, 1965), pp. 97-107.

9. Film, "Drive for Power" and concluding remarks
William L. Langer, "The Social Question," in *Political and Social Upheaval: 1832-1852* (NY: Harper, 1969), pp. 181-98.

10. MID-TERM EXAMINATION

The Revolution Spreads

11. Setting for Technology in America
Louis C. Hunter, "Epilogue" in *A History of Industrial Power in the U.S., 1780-1930*, Vol. 1, (Charlottesville: University Press of Virginia, 1979), pp. 536-41.
Hugo A. Meier, "The Ideology of Technology," in Edwin T. Layton, Jr., ed., *Technology and Social Change in America* (NY: Harper, 1973), pp. 79-97.
"Conclusions," in Nathan Rosenberg, ed., *The American System of Manufactures* (Parliamentary report by George Wallis and Joseph Whitworth, 1855), (Edinburgh: Edinburgh University Press, 1969), pp. 387-89.
Nathan Rosenberg, "Technological Change in the Machine Tool Industry," in *Perspectives on Technology* (Cambridge: Cambridge University Press, 1976), pp. 9-31.

12. Iron Structures: Buildings and Bridges
Carl W. Condit, "Buildings and Construction," in Melvin Kranzberg and Caroll W. Pursell, Jr., eds. Technology in Western Civilization Vol. 1 (NY: Oxford, 1967), pp. 367-92.

13. The Origins of Modern Engineering   PAPER DUE TODAY
Edwin Layton, "Mirror-Image Twins: The Communities of Science and Technology in 19th-Century America," Technology and Culture 12 (October 1971): 562-80.

14. The Mechanization of Agriculture
Caroll W. Pursell, Jr., "Cyrus Hall McCormick and the Mechanization of Agriculture," in Caroll W. Pursell, Jr., ed., Technology in America (Cambridge: MIT Press, 1981), pp. 71-79.

15. Science-Based Technology: The Chemical Industry
John J. Beer, "Coal Tar Dye Manufacture and the Origins of the Modern Industrial Research Laboratory," in Thomas P. Hughes, ed., The Development of Western Technology Since 1500 (NY: MacMillan, 1964), pp. 129-38.
David Noble, "The Wedding of Science to the Useful Arts--I," in America By Design (NY: Oxford, 1977), pp. 3-19.

16. Electricity and Technology: Background
Thomas P. Hughes, "The Electrification of America: The Systems Builders," Technology and Culture 20 (January 1979): 124-61.

17. Science-Based Technology: Electric Power and Communications

18. Industrial Research Laboratories
G. E. Davidson Beehives of Invention (Washington, DC: National Park Service, 1973).

19. Open

20. Conclusion

21. FINAL EXAMINATION   (No change of time except with Dean's permission.

Questions to guide readings

Because some of the readings assigned are rather complex, you may find the questions below helpful. You should be able to answer each of these questions on the basis of the reading, and may be tested on the questions on the mid-term examination.

Chamberlin
1. What was the enclosure movement?
2. What advantages and disadvantages did it have?
3. How did the movement support the industrial revolution?

Mathias

1. What were the three main groups of people affected by changes in agriculture in 18th century England?
2. What agricultural innovations were introduced in 18th century England? Who did they benefit?
3. What new crops were grown in England, and what advantages did they confer upon people and animals?

Population tables

1. Use the tables to determine the most populated occupation groups in the years 1688 and 1851. Can you see any trends?
2. Using the 1851 table, list the major occupations that women held. Why were they poorly represented in most fields?

Ferguson

1. What were some of the impacts of the Newcomen engine?
2. Describe the major features of the Newcomen & Watt engines? What similarities and differences existed between them?
3. What does Ferguson mean by the "genius of James Watt"?

Letter from Boulton to Darwin about Watt's engine

1. What advantages does the Watt engine have over the Newcomen engine and water wheels?

Cardwell "The Origins of Modern Technology"

1. What are the four basic processes in making textiles?
2. What had England's wealth traditionally depended on?
3. When and how did the mechanization of weaving occur?
4. Why was it important that spinning and weaving be efficiently mechanized in the late 18th century?
5. What was unusual in John Smeaton's approach to water wheels?

Cardwell "Arkwright and his Contemporaries"

1. Why did Samuel Crompton call his invention a mule?
2. What further inventions became necessary after the invention of the waterframe, spinning jenny and mule?
3. What does cotton spinning have to do with the way in which people work?

Child Labor in Factories and Mines

1. When did the British Parliament become concerned about labor conditions in industry?
2. What kinds of factories and mines are mentioned in the testimony?

Vialls "Cast Iron"

1. When did iron-making begin? How was it originally done?
2. Why did people smelt with charcoal?
3. What problems were there in smelting with coke? How were they overcome? Who was responsible for the initial success in using coke? Why?

Lewis "Iron and Steel in America"

1. What were the chief uses of iron in Colonial America?
2. What is a blast furnace used for? How does it work?
3. What is charcoal? pit iron? wrought iron? steel?

Evans

1. What technical improvements were made in roads, canals and railroads in England between 1760 and 1840?
2. What impact did these improvements have for sustaining the industrial revolution?

3. What was the synergistic relationship between railroads and canals in the early days of locomotives? How did the relationship change?
4. Did one type of transportation system totally exclude all others after 1825?

Boorstin "Getting There First"

1. What kind of engine was used on steamboats on the Western rivers? Why?
2. What risks did people run in order to achieve the benefits of steamboats?
3. What effects did cultural attitudes towards "getting there first" have on the construction of railroads in America?

Langer "The Social Question"

1. What was the underlying cause of the "pauperization" of much of the European population in the decades preceding 1848?
2. Who managed to live in relative comfort during this period?
3. Why did employers so often hire women and children.

Headrich "Secret Gunboats of the East India Company"

1. Where were steamboats first used in the Third World? When?
2. What were the advantages of iron ships, particularly in the tropics?
3. What was the attitude of the Admiralty to gunboats?

Hunter "Epilogue"

1. What was the major source of power in America until the 1860s?
2. How and why did this change in the 1860s?
3. What were the advantages and disadvantages of the change?

Rosenberg "Technological Change in the Machine Tool Industry"

1. What are machine tools? Why are they essential for industrial growth?
2. When did machinery-producing firms begin to develop? Who first developed them?
3. What is "technological convergence"?
4. Name eight industries that used machine tools.
5. Name a few important machine tools and explain what they are used for.

Rosenberg "Conclusions"

List six features of the United States that Whitworth found very different from England.

Meier "The Ideology of Technology"

1. How has technology been linked with democracy in America?
2. What did Tocqueville have to say about American science and technology?
3. What criticisms were made against American technology and industry in the 19th century?
4. What did the Crystal Palace exhibition of 1853 symbolize?

Condit "Buildings and Construction"

1. When was iron first used for construction? What effects did this innovation have?
2. What innovations did Americans add to traditional techniques for building with wood?
3. What are the main uses for concrete? Why?

Layton "Mirror-Image Twins"

1. What is the traditional picture of the relation between science and technology?
2. Why does Layton think this model is inadequate? Give two reasons.
3. What is the significance for this debate on the rise of the engineering profession?

Pursell "Cyrus McCormick and the Mechanization of Agriculture"

1. What were the chief obstacles to the direct transfer of European agricultural techniques to America?
2. What was the chief bottleneck in American agricultural technology in the first half of the nineteenth century?
3. What were the chief mechanical innovations that removed this bottleneck?

Beer "Coal Tar Dye"

1. Why was the dye industry one of the first science-based industries?
2. Why did companies perform research on new coal dyes?
3. What contributions did Carl Duisberg make?

Noble "The Wedding of Science"

1. What are the roots of the science-technology relationship?
2. What two industries did NOT grow out of traditional craft knowledge?
3. What companies competed in the early electrical industry? Which were most successful? Why?
4. What lessons were learned from World War I?

Hughes "Electrification of America"

1. What does the author mean by "system building"?
2. Who were the three main system builders, and what were their contributions?
3. How does organization and management affect the success of a technology?

Davidson book, Beehives of Invention

1. Describe the vistas of Edison's inventive spirit, (i.e., in what general fields was he interested?).
2. What is meant by "crucibles of creativity"?
3. What associated inventions accompanied the electric light bulb?
4. What major inventions is Edison remembered for?

Mid-term Examination Information

You will be asked to write an essay on one of the following three essay questions. At the time of the test, I will tell you which one to write on. To prepare for it, you may want to make outlines of your arguments and fill them in with details and examples from your readings and class notes. However, you may NOT use the outline during the exam. It is a closed book test. The essay will be worth 40% of the test grade. There will also be a short answer section and a multiple choice section on the exam.

Possible Essay Questions

I. The Industrial Revolution can be characterized by change. In an early lecture, I outlined some changes in:
   a. Building materials
   b. Energy sources

c. Sources of motive power
d. Forms of production
e. Transportation
f. Agricultural techniques

Now that we have discussed some of these changes in detail, I want you to choose and describe three of these changes and discuss how they contributed to the success of the Industrial Revolution. Also explain what impact these changes had on the way people worked and lived.

II. A historian of technology recently wrote:

> "A steam engine is the ultimate symbol of the Industrial Revolution. In every advance that characterizes the revolution, one finds the steam engine playing an integral role in helping to bring that advance to fruition. In the fields of mining technology, the textile industry, iron production and machining, and transportation sectors, the steam engine found its niche and had wide ranging implications, both positive and negative."

In this essay, I want you to support the above statement with detailed arguments and specific examples. Be sure to identify the specific steam engine and describe briefly what feature of it made the advances possible.

III. Technological progress in the Industrial Revolution was often hindered by "missing links" in mechanized processes or difficulties in obtaining, using, and marketing basic materials. These bottlenecks were eventually eliminated as new technologies were developed.

In this essay, describe the bottlenecks in two fields of technology that hampered progress and show how the bottlenecks were removed. Make sure you discuss the major machines or processes involved, and indicate briefly why they worked. Finally, describe the impact of these solutions on the fields of technology and on society in general.

For all these essays, be sure to provide specific examples. You will be penalized for unsubstantiated claims.

Mid-Term Examination

I. Multiple Choice (30 points). In the following question, there are one or two correct answers. Circle the correct answer(s) and write it (them) on your answer sheet.

1. England was the first country to undergo an industrial revolution partly because of A) the surplus of wood resources for smelting iron; B) a tradition of luxury industries; C) a parasitic aristocracy; [✓ D)] geographical isolation; [✓ E)] a national banking system.

2. The dramatic change in agricultural productivity before and during the Industrial Revolution in the period between 1600 and

1800 is associated with A) the three-field system; B) the use of steam engines on farms; C) the McCormick reaper; [✓ D] the enclosure movement; E) John Kay's spinning wheel.

3. The use of coal for many industrial processes in England A) led John Smeaton to develop a method for improving the efficiency of water wheels and Savery steam engines; B) was the direct cause of the "social question;" [✓ C] resulted partly from deforestation; D) resulted in increased charcoal production; [✓ E] resulted in increased coke production.

4. James Watt's contributions to steam engine technology and theory included A) the geometric concept of triangular motion so that the piston could transmit power up and down; B) the invention of a technique for boring smooth cylinders for steam engines; [✓ C] the use of double-acting steam in the engine; [✓ D] the invention of the condenser; D) the invention of the prodenser.

5. Among the important figures in the mechanization of spinning was (were): A) John Kay; B) John Smeaton; [✓ C] Richard Arkwright; D) Henry Jenny; [✓ E] John Wyatt.

6. Which of the following helped American railroad trains run faster than their European counterparts? A) safe, straight tracks; [✓ B] the bogie; C) the twilight zone system; [✓ D] the telegraphy system; E) low pressure engines.

7. Blast furnaces usually had which of the following ingredients put into them? A) coal; B) pig iron; C) carbon dioxide blown in by bellows; [✓ D] iron ore; [✓ E] limestone.

8. Why did employers in industrial England so often hire women and children? A) they enjoyed working more than men; B) Parliament passed laws forbidding hiring discrimination based on sex or age; [✓ C] they worked for lower wages than men; [✓ D] they were more tractable than men; E) they received tax credits for hiring these "hard-core" unemployed.

9. Among those who contributed to the success of the Watt steam engine was (were): A) John Kay; [✓ B] John Wilkinson; C) Sears Roebuck; [✓ D] Mathew Boulton; E) John Smeaton.

10. In the 1830s and 1840s, the British Parliament heard testimony and passed laws concerning A) employment conditions in steam engine factories; B) social security benefit for mine workers; [✓ C] working hours for women and children in textile factories; D) construction of fireproof factories; E) support of the Confederacy in the coming American Civil War.

II. Fill-ins (30 points). In the following sentences, missing words are represented by blanks. On the answer sheet, write your precise and concise answers that correspond to these blanks. They can be answered in a few words. (Correct answers are typed in parentheses, Editor.)

11. The most efficient transport system in England at the beginning of the 19th century (1830s and 1840s) was the (canal) system, which was supplemented by a feeder system of (railroads).

12. What was the major innovation in the production of cast iron made in the early 18th century? Who made it? (use of coke; Abraham Darby) or (puddling; Henry Cort).

13. What modification had to be made to the steam engine before it could be used in textile mills? (rotary motion).

14. Name one advantage of high pressure steam engines. (smaller, lighter weight per horsepower).

15. Name two new crops grown in England in the period before the Industrial Revolution. (clover; lucernes; sainfoin; (leguminous crops)) and (turnips). What advantages did each one offer? (fixed nitrogen in the soil) and (extra feed for animals).

III. Essay (40 points) Be sure to provide specific examples and a complete analysis, not just a recitation of unconnected facts. (For possible questions see mid-term examination information, Editor.)

FINAL EXAMINATION INFORMATION

You will be asked to write an essay on one of the following three essay questions. At the time of the test, I will tell you which one to write on. To prepare for it, you may want to make outlines of your arguments and fill them in with details and examples from your readings and class notes. However, you may NOT use the outline during the exam. It is a closed book test. The essay will be worth 55% of the test grade. You will receive more credit if you analyze the information and organize it in a clear conceptual framework rather than if you just recite facts indiscriminately. The second part of the test will consist of multiple choice quetions based on the readings and class notes. It will be worth 45% of the test grade.

POSSIBLE ESSAY QUESTIONS

I. The history of the steam engine illustrates aptly how a commercially successful technology may emerge without a complete understanding of the basic principles of the field. Watt's first steam engine, for example, predated by 55 years Carnot's treatise that marked the birth of thermodynamics. Since Carnot wrote his paper after having acquired much experience with steam engines, some historians have suggested that 18th and 19th century science owed much to technology.

Consider now either the chemical industry or the electrical communications industry. Explain first why the history of the industry you chose was not similar to that of thermodynamics. In other words, explain how it was a science-based industry. Then describe how and why some of the major innovations of the industry were developed. Finally, explain what effects these innovations had on other technologies and on the way people lived and worked.

II. During the 19th century, iron and iron alloys were used extensively in construction where wood and stone were used previously. Using specific examples, describe how iron became the primary construction material for buildings and bridges. Explain also why iron was a better material than those previously used. Finally, describe what changes in the engineering profession and building techniques were motivated by the increased use of iron.

III. A historian recently wrote:

> A major feature of 19th century technology was the ubiquitous mechanization of the American economy. Machines used in the production and distribution of goods made it possible for the nation to take advantage of its vast (and apparently infinite) material resources that led ultimately to the emergence of the country as a world power.

In this essay, I want you to support this statement. To do this properly, be sure to analyze the reasons for American mechanization and describe two examples in which mechanization eliminated serious problems that inhibited economic growth. Also be sure to explain what the impact of the mechanization was, not only on the people who used the new machines, but also on those who may not have ever seen the machines.

For all these essays, specific examples and appropriate details will help them earn more points.

FINAL EXAMINATION

I. Multiple Choice. (45 points) In the following multiple choice questions, there may be 1, 2, 3, 4, or 5 correct answers. Circle the correct answer(s) and write it (them) in the space to the left of the question. Partial credit will be given.

1. Waterpower served as the predominant source of power in America until about when? And what new source supplanted water at that time? I want two answers here: one from either A, B, or C and one from either D or E. A) The War of 1812; [✓ B)] the Civil War, 1861-65; C) the Spanish-American War, 1898; [✓ D)] Steam power; E) Wind power.

2. According to British observers, a successful atmosphere for manufacturing of goods in America was made possible by A) the limited natural resources that necessitated the use of machines; B) the large number of laboring classes; [✓ C)] widespread education of the masses; D) large number of British immigrants; D) None.

3. The McCormick reaper made it possible A) to harvest grain without using horses or oxen; B) for farmers to transport wheat from the mid-west to the east; C) to thrash (or thresh) grain economically; [✓ D)] to overcome a bottleneck caused by too little farm labor; E) to harvest the newly available land of western Virginia.

4. Building technology in the 19th century was characterized by revolutionary developments in the use of [✓ A)] iron for frames of structures; B) wood in suspension bridges; C) pig iron instead of steel in structures; C) long wooden arches in railroad stations; E) None.

5. According to Ed Layton, the author of the article "Mirror Image Twins," the mirror image dichotomy of scientists and engineers [✓ A)] has contributed to the divergent views of social responsibilities held by the two professions; B) suggests that engineers in universities hold a great amount of prestige; C) leads to the view that science in the 20th century usually develops as a result of technological needs; [✓ D)] means that engineers and scientists have reversed value systems; E) None.

6. Alternating current A) had never been used before Westinghouse introduced it for his power system; B) was favored in the electrical distribution system of Thomas Edison; C) was "damnable" because it was shown to be unsafe by Westinghouse; [✓ D)] was produced from Niagara Falls and transmitted over a large distance to a major city; E) None.

7. The research programs at the Bell Telephone System in the early 1900s A) were established to find ways to open up "phone stores;" [✓ B)] were designed to discover solutions to problems associated with the telephone business; C) were of such a nature that they neglected the pure science aspects of the phone industry; [✓ D)] sought ways to develop transcontinental phone lines; E) None.

8. Among the dynamic forces that Alfred Chandler, author of "The Beginnings of Big Business in American Industry" thinks affected the American business economy from 1815 to 1900 was (were) A) the consolidation of the American population in the East; B) the construction and initial operation of the national highway network; [✓ C)] the application of science to industry; D) the use of electrical engines for transportation; E) None.

9. Among the bottlenecks in agriculture in 19th century America that were resolved was (were) A) refrigeration of wheat in mechanically cooled railroad cars; [✓ B)] preservation of some foods by canning and bottling; C) manufacturing of commercially successful, one piece cast iron plows for the prairies; [✓ D)] producing a plow for easily breaking through the midwestern prairie sod; E) None.

10. Machine tools were used in the late 1800s in industries that produced [✓ A)] sewing machines; [✓ B)] typewriters; [✓ C)] clocks; [✓ D)] firearms; [✓ E)] bicycles.

11. Which statements about the chemical industries is (are) true? A) the dye industry started in Germany and moved to England at the end of the 19th century; [✓ B)] the study of coal tars led to new pharmaceutical products; C) Leblanc's method of making soda was commercially more successful than Solvay's method; D) pollution problems did not exist in these industries. They were the prototypes of clean, safe, industries; [✓ E)] the industries diplaced many "natural" industries.

12. Among the impacts of the use of iron and steel in building structures was (were) A) the return to exclusively empirical methods of building; B) taller buildings made of stone or brick; [✓ C)] the increased use of glass in buildings; D) the decline of interest in bridge building; E) None.

13. Among Thomas Edison's contributions to technology is (are) A) an internal combustion engine for the automobile; [✓ B)] the motion picture camera; C) the invention of artificial beehives; D) the fluorescent lightbulb; [✓ E)] The invention of the process of invention.

14. Of the following inventions, which were associated directly with the accompanying scientific discoveries? A) Chappe's semaphore telegraph and the discovery of electrostatics; [✓ B)] Sommering's telegraph and the discovery of electrolysis; C) Cooke and Wheatstone's telegraph and the discovery of the electromagnet; D) Morse's telegraph and the discovery of the effect of currents on compass needles; E) None.

15. Engineers who designed notable iron bridges included [✓ A)] Thomas Telford; B) Joseph Paxton; [✓ C)] Washington Roebling; D) Hans Oersted; E) William Strutt.

II. Essay (55 points) Be sure to provide specific examples and a complete analysis, not just a recitation of unconnected facts.

(For possible questions see final examination information, Editor)

HISTORY OF TECHNOLOGY 4213
TECHNOLOGY IN THE 20TH CENTURY

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COURSE DESCRIPTION:

Technological change has occurred rapidly in the 20th century, contributing to the remaking of our physical and intellectual environment. In this course, we will examine the causes and manifestations of technological evolution and discuss how humankind, especially in America, has benefited from it and accommodated to it. By making case studies, we will see how technology has changed in form (such as how new transportation systems enabled faster travel) and in organization (as in industrial reseach laboratories). In addition, a major focus of the course will concern how the government and public have become increasingly involved in motivating and limiting technological innovations.

Generally, the course seeks to develop an understanding of the forces and circumstances that affect the way technology evolves. Historical methods and examples will be employed to inform us about these forces so that we may become aware of how they continue to operate in the current world.

This course is the third of a three-quarter sequence in history of technology. In the fall, we offer History of Technology 4211, which concerns the history of ancient and medieval technology from prehistoric times to 1700. The winter course, History of Technology 4212, deals with the period known as the Industrial Revolution, from 1700 to 1900.

COURSE REQUIREMENTS:

(See syllabus for History 4211, including paper assignment, Editor.)

REQUIRED READINGS:

Richard Hutton, The Cosmic Chase (NY: Mentor, 1981).
About 25 short articles that are available in duplicated form.
The required readings are listed after the title of each lecture.

TENTATIVE SCHEDULE AND READING ASSIGNMENTS:

(This quarter-length course meets bi-weekly for a total of 21 sessions, Editor.).

1. Course Introduction
   Clipping on side effects of science and technology, in Roanoke Times and World News (11 June 1981): A5.

2. Background--American Technology in the 19th century
   C. W. Pursell, Jr. and M. Kranzberg, "The Promise of Technology for the Twentieth Century;" in Melvin Kranzberg and Caroll W. Pursell, Jr., eds., Technology in Western Civilization vol. 2. (NY: Oxford, 1967), pp. 3-10.
   H. Meier, "Technology and Democracy," in John G. Burke and Marshall C. Eakin, eds., Technology and Change (San Francisco: Boyd & Fraser, 1979), pp. 211-13.

3. Technology and Industry
   D. J. Boorstin, "Time Becomes Fungible," in Daniel J. Boorstin, *The Americans: The Democratic Experience* (NY: Random House, 1973), pp. 361-70.
   F. W. Taylor, "Scientific Management," in Caroll W. Purcell, Jr., ed., *Readings in Technology and American Life* (NY: Oxford, 1969), pp. 240-48.

4. Revolution in transportation: Automobiles
   L. Bryant, "The Origin of the Automobile Engine," in *Scientific American* 216 (March 1967): 102-12.
   J. J. Flink, "Henry Ford and the Triumph of the Automobile," in Caroll W. Pursell, Jr., ed., *Technology in America* (Cambridge, MA: MIT, 1981), pp. 163-75.

5. Revolution in transporation: Airplanes
   F. E. C. Culick, "The Origins of the First Man-Carrying Airplane," *Scientific American* 241 (July 1979): 86-100.

6. Women and Technology
   R. S. Cowan, "The 'Industrial Revolution' in the Home," *Technology and Culture* 17 (January 1976): 1-23.
   R. S. Cowan, "From Virginia Dare to Virginia Slims," *Ibid*., 20 (January 1979): 51-63.

7. Nature of Innovation
   J. Schmookler, "Economic Sources of Inventive Activity," in Burke and Eakin, eds., *Technology and Change* pp. 396-99.
   J. Jewkes, D. Sawers, and R. Stillerman, "The Sources of Invention," in *Ibid*., pp. 406-16.

8. Open

9. MID-TERM EXAMINATION

10. Technology and Government
   J. P. Baxter, "The Scientists Organize, 1940;" in Pursell, ed., *Readings in Technology*, pp. 384-93.
   H. D. Smyth, "The Atomic Bomb, 1945," in *Ibid*., pp. 394-99.
   V. Bush, "A New Relationship, 1945," in *Ibid*., pp. 408-22.
   H. Newell, "Response to Sputnik," in *Beyond the Atmosphere: Early Years of Space Science* (Washington: NASA, 1980), pp. 87-99.

11. Technology for Government: Space Race
   Hutton book, chs. 1-6.

12. The Space Program after Apollo
   Hutton book, chs. 7-10.

13. The Restive Public of Science and Technology PAPER DUE TODAY
   D. Nelkin, "Science and Technology Policy and the Democratic Process," in Albert H. Teich, ed., *Technology and Man's Future*, 3rd ed. (NY: St. Martin's, 1981), pp. 270-93.
   A. M. Weinberg, "Science and Trans-Science," *Minerva* 10 (April 1972): 209-22.

14. Energy Use in American History
J. G. Burke, "Multiplying Energy;" in D. K. Newman, et al. Energy and the Way We Live (Article booklet for the 12th course by newspaper) (San Francisco: Boyd & Fraser, 1980), pp. 10-12.
D. Bell, "Plenty and Profligacy," in Ibid., pp. 13-15.
N. Metzger, "Prelude to Crisis," in Ibid., pp. 16-18.

15. The Growth of the Electric Power Industry
"The Utility Industry," Electrical World 181 (#11, 1974): 44-52.
R. Morgan, "The Roots of Rate Design," in The Rate Watcher's Guide (Washington: Environmental Action Foundation, 1980), pp. 3-16.

16. Nuclear Power and Public Policy
W. J. Lanouette, "Nuclear Power--An Uncertain Future," in Melvin Kranzberg, Timothy A. Hall, and Jane L. Scheiber, eds., Energy and the Way We Live (San Francisco: Boyd & Fraser, 1980), pp. 331-43.
M. Kayton, "Nuclear Power--Yes," in Ibid., pp. 344-46.
S. Love, "It Was Too Good to be True," in Lee Stephenson and George R. Zachar, eds., Accidents Will Happen: The Case Against Nuclear Power (NY: Harper and Row, 1979), pp. 6-15.
P. Bechmann, "The Nuclear Monologue," in The Health Hazards of Not Going Nuclear (Boulder: Golem Press, 1976), pp. 11-34.
"Overview," from The President's Commission on the Accident at Three Mile Island (John G. Kemeny, chairman) (Washington: Government Printing Office, 1979), pp. 7-25.

17. Electronics and Computers
Original accounts of the invention of the transistor, in Time (12 July 1948): 54; and Newsweek (6 Sept. 1948): 44.
T. A. Margerison, "Computers," in Trevor I. Williams, ed., A History of Technology. Vol 7, pt. 2 (Oxford: Clarendon, 1978), pp. 1150-1203.

18. The Decline of American Technology?
W. Stockton, "The Technology Race," New York Times Magazine, (28 June 1981): 14-18, 49-56.
"That Winning American Style," Time (19 October 1979): 86-88.

19. Open

20. Course Conclusion

21. FINAL EXAMINATION (No changes of time except with Dean's permission.)

Questions to Guide Readings

Pursell

1. Give examples of the acceleration of technology in the 19th century.
2. Why are the 1900s known as the "American century"?
3. Was everyone optimistic about the future of technology and society?

Meier

1. What is meant by "surrender to the machine"?
2. What is the "materialistic approach" to technology?

Boorstin

1. What does "efficiency" mean in the 20th century American gospel?
2. What are the basic features of Taylor's scientific management?
3. What were the results of Mayo's experiments?

Taylor

1. How did Taylor eliminate "soldiering" in the factory?

Bryant

1. What are the basic advantages of the internal combustion engine?
2. What other engines did the very early IC engines resemble?
3. Why did Otto employ a four-stroke engine?

Flink

1. Why did the Model T have "more important consequences than Lenin's socialist revolution"?
2. Why did the automobile culture develop so rapidly in the U.S.?
3. Describe Ford's innovations.

Culick

1. What did Cayley, Penaud, Lilienthal, & Chanute contribute to aeronautics?
2. What is "wing-warping"?
3. Why were the Wright brothers successful in building an airplane?

Cowan 1

1. What is meant by the "industrial revolution in the home"?
2. Describe some machines that helped reduce household drudgery.
3. Did all machines save work?
4. How did the "industrial revolution" change the structure of the home?
5. What was the role of advertisers in the 1920s?

Cowan 2

1. What basic differences between men and women have effects on the technologies they use?
2. What are the "economic facts of life" for women?
3. How have household tasks changed for women?
4. How are women "antitechnocrats"?

Schmookler

1. What motivates invention, according to Schmookler?
2. What are some psychological factors for invention?
3. What is an almost inevitable accompaniment of progress?

Jewkes

1. What are some assumptions concerning the nature of technological innovation?
2. What does the example of nylon's history tell us?
3. Where has the emphasis on public endeavor been placed in recent times? What are the possible results of such a policy?

Baxter

1. Why did the British government see the military need for science and technology before the American government?
2. Why couldn't the National Academy of Sciences organize science and technology before World War II?
3. How did the NDRC support research?
4. What were the accomplishments of NDRC research contracts?

Smyth

1. How much did the Manhattan project cost up to June 1945?
2. Who were involved in the building and testing of the bomb?
3. What was the justification for using the weapon?

Bush

1. What is Bush's basic thesis concerning science, technology, and the government? How did he develop this thesis?
2. What benefits did he see accruing from research in science?
3. What did Bush mean by "scientific capital"?
4. What was Bush's program for action?
5. What did Bush say about "basic" research? Industrial research?
6. What were Bush's fundamental requirements for a national science policy?

Newell

1. Why did the U.S. become so competitive with the Soviet Union in space activities?
2. What were the two major interest groups vying for control of the U.S. space program?
3. Why did space science flourish within the new NASA?
4. What kind of space program did the U.S. have before NASA?

Hutton

1. What did the German rocket program contribute to the U.S. space program?
2. What were the political, diplomatic, and psychological ramifications of Sputnik?
3. Why did the Russians beat us into space?
4. Why didn't the military agencies take over the space program?
5. What was meant by "spam-in-a-can"?
6. What were the ramifications of events occurring on 12 April 1961?
7. What was the significance of the Voskhod flights?
8. What problem did NASA encounter in the mid-1960s?
9. What occured in the space program soon before and after Americans walked on the moon?
10. Why did NASA struggle to survive after the lunar landing?
11. What were some arguments against the Apollo program and space exploration in general?
12. What tangible and intangible benefits did the space program provide?
13. What is the "space underground"?
14. What are the prospects of space research and development?

Nelkin

1. Why is the relationship between science and the public being renegotiated?
2. What are the public's attitudes toward science and technology?
3. What are the implications of a "technical elite?"
4. What are the mechanisms and channels of public participation in science and technology decision making? What problems and implications are involved?

Weinberg

1. What does "trans-science" mean?
2. Why is engineering a trans-science?
3. What is the "republic of trans-science"? How does it differ from the "republic of science"?
4. What are the advantages and disadvantages of conducting the trans-scientific debate in public?

Burke, Bell, and Metzger

1. Why was the 1952 Materials Policy Commission forecast so accurate?
2. Why did some people think that regulation would help the electric power industry?
3. How would you describe the growth in electricity sales up until 1974?

Morgan

1. How was electricity priced in the industry's early days?
2. What were the three types of electricity costs?
3. What were the advantages and disadvantages of promotion?

Lanouette

1. What caused the uncertain future for nuclear power?
2. What are the unresolved safety problems and other concerns surrounding nuclear power?
3. How does the public view nuclear power?

Kayton

1. Why is Kayton still obtimistic about nuclear power?

Love

1. What hopes did people have for nuclear power?
2. How did the government help the nuclear power industry?

Beckmann

1. What is meant by a "nuclear monologue"?
2. How did the nuclear industry become so defensive?
3. What are the arguments for the superiority of nuclear fuel over fossil fuel?
4. What is the opinion of scientists and engineers on the nuclear power issue?

President's Commission on Accident at TMI

1. What were the causes of the TMI accident?
2. How serious was the accident?
3. How effectively did the NRC handle the accident?
4. What was the basic problem with the TMI reactor? What kind of business attitude prevailed before the accident?

Margerison

1. What are the pre-20th century roots of computers? What were the contributions of Leibnitz, Pascal, Babbage, and Hollerith?
2. What is the difference between an analog and digital computer?
3. Why were the first electronic computers designed?

Original Accounts of Transistor

1. What hopes did people raise for the transistor?

Stockton

1. Why is American technology faltering?

2. What will remedy the situation?
3. What is the consequence of reduced spending for science and technology?

American Style

1. Why have Americans won so many Nobel Prizes?
2. What portents of decline exist?

MID-TERM EXAMINATION INFORMATION

You will be asked to write an essay on one of the following three essay questions. At the time of the test, I will tell you which one to write on. To prepare for it, you may want to make outlines of your arguments and fill them in with details and examples from your readings and class notes. However, you may NOT use the outline during the exam. It is a closed book test. The essay will be worth 40% of the test grade. You will receive more credit if you analyze the information and organize it in a clear conceptual framework rather than if you just recite facts indiscriminately. The second part of the test will consist of multiple choice questions based on the readings and class notes. It will be worth 60% of the test grade.

POSSIBLE ESSAY QUESTIONS

1. Big companies seem to have played major roles in the history of technology during the 20th century. This constituted a major change over the early and mid-19th century. In this essay, describe first how large corporations emerged in the American economy at the end of the 19th century. Then provide three examples of important innovations in technological products or processes that were made by big corporations. Why were these innovations so important? Next, describe why big companies were able to displace individuals and dominate the scene. Finally, discuss the impact--positive and negative, potential and realized--that these huge organizations have had on society.

2. While big companies seem to dominate the technological landscape of the 20th century, individuals have often been significant contributors to innovation as well. Often these people demonstrated inventive talent in making single, yet seminal, innovations. Others synthesized elements of existing technologies and ultimately became entrepreneurs who controlled the big corporations. In this essay, discuss in detail three individuals who made technological innovations in the 20th century. What was so important about their contributions? How did other people or companies use the innovations? What impacts on the economy and society did these individuals have?

3. The widespread use of electricity had a transforming effect on 20th century life. Not only did electricity provide the light by which people's days were "expanded," it also powered numerous machines in the factory and home that modified the ways people worked. In this essay, describe how electricity became ubiquitous in both the home and factory. Then analyze the impact electricity had on the different settings. Did one class or group in the population benefit more than others from the use of electricity?

Mid-Term Examination

I. Multiple Choice (33 points) In the following questions, there are one or two correct answers. Circle the correct answer(s) and write it (them) on your answer sheet.

1. The materialist approach to technology: A) provided for high quality products for the small upper class market; B) was of little concern to engineers, inventors, mechanics, and their spokesman; [✓ C] found acceptance among people who wanted to get things done quickly and who wanted "things" that brought physical comfort; D) consists of the use of natural resources that are at hand for technological advancement in developing nations; E) required the existence of a large, well-trained, engineering elite.

2. Taylor thought he could eliminate "soldiering" in factories by A) giving more authority to management and taking it away from foremen, who tended to be too harsh; [✓ B] providing workmen with large salary increases; C) giving workmen great freedom in performing their tasks; [✓ D] assuring workmen that other people in the factory would not become unemployed if their output increased; E) eliminating forced labor by the military services.

3. The multi-piston (two or four piston) arrangement of the internal combustion engine had the function of: A) reducing the number of moving parts in the engine; B) allowing internal combustion engines to use gasoline; [✓ C] helping to drive out exhaust gases; D) helping to provide a stratified charge; E) lowering fuel consumption.

4. Ford's Model T automobile became a relatively inexpensive car in the 1920s because: A) demand was low; supply was high; B) Ford introduced techniques of mass production and assembly lines that had never been used before in unison; [✓ C] there was basically only one model of car that Ford sold; D) Ford workers were underpaid; E) Ford sold the car at a loss to gain a competitive edge.

5. Among the techniques used by the Wright brothers in designing their successful airplane of 1903 was (were): [✓ A] changing the shape of the wings in flight; B) use of water tunnels for testing wing shapes and drag forces; C) use of a lightweight steam engine for power; [✓ D] adopting the type of wing structure devised by Octave Chanute; E) use of retractable landing gear to reduce drag.

6. Some aspects of 19th century technology and American society that transferred to the 20th century included: A) a popular belief that technological progress should be encouraged by the government; B) an extensive highway network that enabled companies to develop national markets; [✓ C] large companies that employed scientific methods to develop new commercial products; D) skepticism over technological advance; E) dependence on British factores for cheap products.

7. Contributions to aeronautics made by Cayley, Penaud, Lilienthal, and Chanute include: A) wing warping; B) simulation of a bird's flight for airplanes; [✓ C] development of airfoils; D) concept of lighter-than-air flight with balloons; [✓ E] analysis of the different forces acting on airplanes.

8. Associated with the concept of mechanization of tasks in 19th century America was (were): A) labor surplus; [✓ B] labor shortage;

C) "tooling" machines; D) the "British System of Manufactures"; E) use of assembly lines to produce cars.

9. The "industrial revolution in the home" A) describes armies of women and children toiling in mills; B) referred to the return of manufacturing in the home, i.e., the re-creation of "cottage industries"; [✓ C)] refers to the use of new appliances in the home that eased the burden of chores; [✓ D)] implied to one school of thought that women's time in doing work in the home remained the same in the last 60 years; E) meant the elimination of sex-typed jobs.

10. Schmookler contends in his article on sources of innovation that inventive activity may result from which of the following: A) satisfaction with existing conditions; [✓ B)] latent demand; [✓ C)] antecedent scientific discoveries; D) expectation of economic penalties; E) regressive patent laws.

11. The term "rationalization" of industry often refers to: A) the use of mathematics to determine fair wages for managers of companies; [✓ B)] a "scientific" approach toward the management of labor; C) government support of industry; [✓ D)] assembly line, mass-production techniques; E) college-educated managers.

II. Fill-ins (27 points) In the following sentences, missing words are represented by blanks. On the answer sheet, write your precise and concise answers that correspond to these blanks. They can be answered in a few words. (Correct answers are typed in parentheses, Editor.)

12. List thre[illegible]elds in which technological "acceleration" was evident i[illegible] 19th century. (Communications), (transporta[illegible]n), (manufacturing).

13. The symbol of Taylor's scientific management was the (stopwatch).

14. Two advantages of the internal combustion engine were: (higher thermal efficiency) and (light weight, or no need for condenser).

15. Give an example of what Cowan means by women being "anti-technocrats." (Women opposing high-tech advances like SST, nuclear plants, etc.).

16. Give two reasons why the bicycle was an important technological predecessor to the automobile. (Much of the same technology used (steel, tubes, tires), led to road improvement movement).

III. Essay (40 points) Be sure to provide specific examples and a complete analysis, not just a recitation of unconnected facts.

(For possible questions see mid-term examination information, Editor.)

FINAL EXAMINATION INFORMATION

You will be asked to write an essay on one of the following three essay questions. At the time of the test, I will tell you which one to write on. To prepare for it, you may want to make outlines of your arguments and fill them in with details and examples from your readings and class notes. However, you may NOT use the outline during the exam. It is a closed book test. The essay will be worth 50% of the test grade. You will receive more credit if you analyze the information and organize it in a clear conceptual framework rather than if you just recite facts indiscriminately. The second part of the test will consist of multiple choice and short answer questions based on the readings and class notes.

POSSIBLE ESSAY QUESTIONS

I. Governmental agencies and institutions have played important roles in American technological development during the 20th century. In this essay, explain the effects of the government as it has played each of the following roles:

1) Advocate of technological innovation
2) Regulator of technological innovation
3) Legislative arbiter of technological innovation (i.e. providing the legislative authority to proceed or limit a technology).

For each role, provide at least one example of the government's involvement in technology. Make sure you exlain why the government was involved in the technology in the first place. Also describe what might have occurred without government involvement. (Would the technological innovations have been produced or limited in the absence of governmental institutions?) Finally, provide a brief rationale for either the abolition or continued existence of the government's role playing in the development of technology.

II. The twentieth century has witnessed the emergence of "big" technology--technology that is highly complex, dependent upon numerous synergistic systems, and very costly. Examples of this technology include a) space technology, b) electric power systems, c) nuclear power technology, and d) computers. Choose three of these four examples and answer all these questions:

1) Why are these considered "big" technologies?
2) What factors influenced their development?
3) How has the public responded to them?
4) What future developments occurring in the United States do you see for these technologies? Why?

III. A historian recently wrote:

> In the 20th century, technology has become public. No longer does the engineer make the decisions about his work alone and in a social vacuum. He now works in a context of politics and public concern. His assumptions and choices are often questioned, and well intentioned technological "fixes" to problems are often discarded in the public arena.

In this essay, use information derived from the second part of the course, readings, and experience to attack and/or support this statement. In doing so, use the concept of "trans-science" (make sure you define it, too) and provide three examples of relevant situations/issues. Why does or doesn't this new situation exist? What are the problems and implications of this new trend?

FINAL EXAM

I. Fill-ins. (22 points) In the following sentences, missing words and phrases are represented by blanks. On a separate sheet, write your precise and concise answers that correspond to these blanks. (Correct answers are typed in parentheses, Editor.)

1. Two government agencies that helped organize American science and technology during World War II were (NASA) and (OSRD). One agency that was unable to help much because of its organization was (National Academy of Sciences).

2. An example of what V. Bush considered scientific capital would be (basic scientific research). In 1945, what kind of national science policy did the United States have for the post-war period? (None)(one word). What policy did Bush suggest be pursued? (Support for basic research which would lead to new technologies).

3. An event similar in impact to the Sputnik launch in 1957 occurred in 1961. What was it? (Russian launch of man in space). What American program did it lead to? (Moon landing program). What groups of people disapproved of the program? (Lots of scientists; civil rights activists).

4. Soon before and immediately after men walked on the moon, Congressional support for NASA programs changed in what way? (No more massive support for NASA). President Johnson argued that a certain space program was "worth ten times what the country was spending on military and civilian programs combined". What were these operations? (Military spying operations from space). What goal did attendees of the Princeton conference establish? (Space colonization).

5. Among the warning signs of an impending energy crisis in the 1970s was a government report. What was its title? (1952 Materials Policy Commission Report). Give two other warning signs of an energy crisis. (Difficulties in meeting peak electrical demands) (Increasing dependence on foreign oil).

6. The early 20th century saw numerous advances in the production of electric power. Give an example of a financial innovation (Holding companies) and a technical innovation (Steam turbines). Who were responsible for these innovations? (S. Z. Mitchell) and (C. A. Parsons).

7. The electric power industry promoted energy sales heavily in the 1950s and 1960s. Give two reasons for why increased energy sales, which stimulated the need for costly capital investments, were promoted. (Don't just say to make money--be more specific.)

(Money could be made just by borrowing it due to regulated prices), (Power plants became more efficient and cost-efficient over the years as demand increased). Today, high fuel costs are among the reasons why the industry has stopped promoting indiscriminant use of electricity. What is another reason? (Bond interest rates are higher than can be recovered by regulated rates).

II. Multiple choice (28 points). In the following multiple choice questions, there may be one or two correct answers. Circle the correct answer(s) and write it (them) on your answer sheet.

8. Among the reasons for the uncertain future of nuclear power in the U.S. is (are) A) Poorly designed control panels in coal powered plants; [✓ B)] Government regulatory policies concerning nuclear waste; C) While cheaper than coal power, nuclear generated electricity brings a small amount of radiation into the homes of users; D) Public apathy.

9. What hopes did journalists and scientists discuss for nuclear power immediately after World War II? [✓ A)] Nuclear power generating stations would be more reliable than coal powered plants; B) Nuclear power would provide the means for inter-galactic travel; [✓ C)] Nuclear power would be used as a power source for automobiles; D) Nuclear power was pollution- and radiation-free.

10. Bell Telephone's research policy included which of the following approaches? A) Performing research in those areas where a profit was most likely to be gained; B) Whenever possible, contract out research to universities; [✓ C)] Support basic research in fields that might have something to do with Bell systems; D) Make sure groups working on basic research carried their projects through the developmental and commercial stages.

11. American technology has been slipping recently because: A) The U.S. is not investing as much in applied research as it does on basic research; B) Faculty members of university engineering departments are leaving to get better paying jobs in foreign countries; [✓ C)] Industrial companies tend to pursue short-term profits with the technology at hand rather than focus on greater long-term profits from new technologies; D) The anti-technology movement has caused industries to siphon off funds from technological developments for public relations efforts.

12. The transistor has become symbolic of "good" American technology in the post-World War II era because: A) It represents the goals and organization of science and technology that is heavily subsidized by the federal government; B) It was developed with the aid of Russian scientists, which reminds us of the cooperation between the U.S. and Soviet Union just before the Cold War; C) It was developed with basic scientific theories that require only good funding for development into a practical technology; [✓ D)] It was a result of a complex relationship between the micro-environment of Bell Labs and links with outside communities of scientists and engineers.

13. In what field(s) does Stockton ("The Technology Race") see major breakthroughs occurring in electrical engineering? A) Improved communications systems employing lasers; [✓ B)] Use of magnetic

bubbles for computer memory; C) Use of radioactive elements as a timing device for long term voyages in space; D) Employment of electronic pacemakers for heart disease patients.

14. Which statement(s) about the history of computers is (are) true? A) Computers were made possible in the 20th century (and not earlier) only because the hardware had advanced sufficiently; B) The transistor was a necessary invention for the development of the electronic computer; [✓ C] Electronic computing was aided by Shannon's work on base 2 logical circuits; D) Computer languages such as FORTRAN were replaced by easier programming with binary systems.

III. Essay (50 points) Be sure to provide specific examples and a complete analysis rather than a recitation of unconnected facts.

(For possible questions see final examination information, Editor.)

HISTORY OF TECHNOLOGY I

James H. Schaub

Professor of Civil Engineering
Affiliate Professor of History
University of Florida
Gainesville, Florida

The development of technology and engineering from antiquity to approximately 1750 with emphasis on the relationship of this development to the growth of western civilization.

Goals: To introduce the student to the historical development of technology and to emphasize the role technology has played in the social, economic and cultural development of western civilization to c1750.

Prerequisites: None

NOTE: This course is jointly listed by the Department of History where it is a part of the History of Science, Technology and Medicine program and by the Department of Civil Engineering. It is accepted as General Education credit by the University of Florida in the Humanities area.

Required Texts:

L. Sprague de Camp, The Ancient Engineers (Cambridge, MA: MIT Press, 1970).
Jean Gimpel, The Medieval Machine (NY: Holt, Rinehart & Winston, 1976). Paper ed. (Hammondsworth, England: Penguin Books, 1977).
D. S. L. Cardwell, Turning Points in Western Technology (NY: Science History Publications, 1972).

Readings from Scientific American
1. N. Smith, "Roman Hydraulic Technology," 238 (May 1978): 154-61.
2. L. White, "Medieval Uses of Air," 223 (August 1970): 92-100.

Other selected readings in duplicated form are available from library reserve as appropriate.

Assignments: All reading assignments are shown on the outline and are to be completed prior to class time.

Assigned readings are essential as background material for the class lectures. Other readings may be assigned through class handouts as appropriate. Please note that the lectures are not intended to review the reading assignments but to supplement them.

Spot quizzes may be given on assigned readings.

Requirements and Grading:

Attendance is expected. Unexcused absences will be cause for reduction in the final grade.

There will be three (3) one hour tests as shown on the schedule. The tests will be composed of approximately one-half essay type questions and one-half objective questions. Each test will count 25% of the term grade.

A term paper will be required in lieu of a final examination and will count 25% of the term grade. The paper is to be 7-10 pages in length, typed and double spaced with references in an acceptable style. The paper may be on any topic of your choice relating to the technology of Europe or the Middle East for the period prior to 1750. Regardless of topic, the paper must include a discussion of the technology involved and its impact on the society of the period. It is suggested you discuss your topic with the instructor before the due date of the term paper outline. The term paper is due at the scheduled class time.

Please note: The term paper will be graded on the mechanics of good writing (spelling, grammar, form, organization, etc.) as well as content. FURTHER, plagiarism in any form will not be tolerated and will be cause for a zero (0) grade on the work in question and possible failure of the course.

Some students may prefer to complete a model of a technological device from the period covered in the course in lieu of a term paper. This is acceptable subject to the prior approval of the instructor. The model must be not more than 18" square and 12" high and must be accompanied by a 1-2 page description of the work. The model makers will be expected to present and describe these models to the class during the final week of the course.

Suggested topics for the term paper and for models are shown on the following pages. These suggestions are that only--there are many other suitable topics. You are encouraged to develop your own subject to fit your interests.

POTENTIAL TERM PAPER TOPICS

Land Reclamation
The Development of the Arch
Water Supply Before the Roman Aqueducts
Greek Science and Its Relationship to Technology
The Development of Truss Bridges
The Water Supply at Marly
Developments in Ship Building
Brothers of the Bridge
Galileo and Developments in Technology
The Technological Contributions of Huygens
Mining Methods in the Middle Ages
Roman Building Construction
The Canal du Midi
Sanitation Before 1700
The Technological Achievements of (any of the following)
    Vauban
    Stevin
    Palladio
    Alberti
Technology and the Growth of Government
Parallel Growth of Technology and the City
Building Construction in Pre-Roman Times
Technology and Ceramics
Iron and Weapons of War
Paper

Alchemy and the Early Development of the Chemical Industry
Energy Crises Before 1700
Roads and Turnpikes Before Telford
Corps des Ponts et Chausses
Slavery and Technology in Greece and Rome
Environmental Crises Before 1750

SUGGESTED MODEL PROJECTS

1. Hero's Steam Turbine
2. Trajan's Bridge over the Danube
3. Water Clock
4. Examples of da Vinci's Technology
5. The Arch in Various Forms
6. Roman Crane
7. Cross section of a Romanesque Basilica
8. Cross section of Gothic Cathedral
9. Greek Pneumatic Devices

There are many other possibilities. See instructor to discuss, if you wish to do the model rather than the term paper.

HIS 3470

History of Technology

TOPIC and READING ASSIGNMENT

Note, this course meets three times a week, Editor.

CLASS
SESSION

1. Introduction

R. J. Forbes, The Conquest of Nature (New York: Mentor Books, 1969), pp. 19-33.

2. Irrigation

DeCamp, pp. 42-82.
P. F. Drucker, "The First Technological Revolution," Technology and Culture 7 (Spring 1966): 143-51.
N. Smith, Man & Water (London: Peter Davies, 1976), pp. 3-18.

3. Mining and Metals

T. K. Derry and T. I. Williams, A Short History of Technology (Oxford: Oxford Press, 1961), pp. 114-128.

4. Pyramids, Building and Technology

DeCamp, pp. 18-42.

5. Technology and the Golden Age of Greece

DeCamp, pp. 83-99, 117-126.

6. Technology and the Golden Age of Greece (continued)

   DeCamp, pp. 255-63.
   H. Hodges, Technology in the Ancient World (New York: Alfred A. Knopf, 1970), pp. 208-19.
   Plutarch, edited by E. Fuller, Lives of the Noble Romans (Garden City, NY: Nelson Doubleday, Inc., 1959), pp. 83-90.

7. Rome - The Growth of Urban Life

   DeCamp, pp. 172-92.

8. Roman Technology - Structures

   DeCamp, pp. 192-216.

9. Roman Technology - Water Supply

   Smith, "Roman Hydraulic Technology."

10. Roman Technology - Roads

    DeCamp, pp. 216-42.
    R. J. Forbes, Man the Maker (New York: Abelard-Schumann Ltd., 1958), pp. 69-82.

11. TEST # 1

12. Agricultural Revolution of the Middle Ages

    DeCamp, pp. 263-73.
    Gimpel, pp. 29-58.

13. Agricultural Revolution of the Middle Ages (continued)

    H. Thomas, History of the World (New York: Harper & Row, 1979), pp. 88-97.

14. Wind and Water Power

    DeCamp, pp. 242-50.
    White, "Medieval Uses of Air."
    N. Smith, Man & Water, pp. 137-49.

15. Beginnings of Mechanization

    DeCamp, pp. 336-71.
    Gimpel, pp. 1-29.

16. Islam and the Transfer of Technology

    R. J. Forbes, Man the Maker, pp. 89-102.

17. Islam and the Transfer of Technology (continued)

18. Technology and Gothic Construction

DeCamp, pp. 357-60.
Gimpel, pp. 114-46.

19. Technology and Gothic Construction (continued)

20. Renaissance - Artists and Technologists

DeCamp, pp. 374-76, 389-408.

21. Renaissance - Artists and Technologists (continued)

F. Klemm, *The History of Western Technology* (Cambridge, MA: MIT Press, 1964), pp. 199-205.

22. Renaissance - Artists and Technologists (continued)

23. Time and Its Measurement

Gimpel, pp. 147-70.
Cardwell, pp. 12-19.
L. Mumford, *Technics and Civilization* (New York: Harcourt, Brace & World, Inc., 1934), pp. 12-18.

24. Metals, Banking and the Reformation

Gimpel, pp. 59-74.
G. Agricola (translated H. and L. Hoover), *De Re Metallica* 1912 Reprint ed. (New York: Dover Publications, Inc., 1950), pp. v-xi.

25. Galileo, Science and Technology

Cardwell, pp. 36-46.

26. Film

27. TEXT # 2

28. Development of Mechanics

Gimpel, pp. 171-98.

29. Printing and Expansion of Technology

DeCamp, pp. 322-27.
Cardwell, pp. 19-29.

30. Printing and Expansion of Technology (continued)

31. Background of the Industrial Revolution

32. Textile Industry

Cardwell, pp. 73-78.
W. English, The Textile Industry (London: Longmans, Green & Co., Ltd. 1969), pp. 1-9, 113-24.

33. Textile Industry (continued)

Cardwell, 94-101.

TERM PAPER OUTLINE DUE

34. The Factory and the City

W. English, The Textile Industry (London: Longmans, Green & Co., Ltd. 1969), pp. 1-9, 113-24, (review again).

35. The Factory and the City (continued)

36. Steam and the Power Revolution

Cardwell, pp. 51-59.
F. Klemm, The History of Western Technology, pp. 73-75.

37. Steam and the Power Revolution (continued)

Cardwell, pp. 66-72.
D. S. L. Cardwell, Steam Power in the Eighteenth Century (London: Sheed and Ward, 1963), pp. 60-79.

38. Steam and the Power Revolution (continued)

Cardwell, pp. 82-93.

39. Steam and the Power Revolution (continued)

40. TEST # 3

41. Iron and Steel

T. K. Derry and T. I. Williams, A Short History of Technology, pp. 128-47.

42. Iron and Steel (continued)

A. Burton, Remains of a Revolution (London: Sphere Books, Ltd., 1974), pp. 55-67.

43. Iron and Steel (continued)

44. PROJECTS AND TERM PAPERS DUE

HISTORY OF TECHNOLOGY II

James H. Schaub

Professor of Civil Engineering
Affiliate Professor of History
University of Florida
Gainesville, FL

The development of technology and engineering from approximately 1750 to World War I with emphasis on the relationship of this development to the changing patterns of life in western civilization.

PURPOSE OF COURSE:

This course is intended to review the historical development of technology and its social, economic, and cultural content in Europe and the U.S.A. during the period 1750 to W.W.I. The tremendous growth of technology in all areas during this era excludes the possibility of a comprehensive coverage of the topic. Certain key areas will be discussed and the student will have the opportunity to pursue any interest not covered through assigned essays or papers.

The format will be lectures supplemented by films and slides. In general, each topic will be considered in three phases: (1) the historical background at the time of the development; (2) the technological development in semi-technical terms; and (3) the social and cultural impact of the particular development.

PREREQUISITES: None

NOTE: This course is jointly listed by the Department of History where it is a part of the History of Science, Technology and Medicine program and by the Department of Civil Engineering. It is accepted as General Education credit by the University of Florida in the Humanities area.

TEXTBOOKS:

T. K. Derry and T. I. Williams, *A Short History of Technology* (Oxford: Oxford Press, 1960).
Elting E. Morison, *From Know-How to Nowhere* (NY: Basic Books 1974).
Joseph and Francis Gies, *The Ingenious Yankees* (NY: Thomas Crowell, 1976).
Other selected readings from library reserve as appropriate.

ASSIGNMENTS:

All reading assignments are shown on the outline. These readings are an integral part of the class and are essential for the class lectures and discussions. Other readings may be provided, as appropriate, by class handouts. Please note that the lectures are not intended to repeat the reading assignments but to supplement and extend them.

REQUIREMENTS AND GRADING:

Attendance is expected. Unexcused absences will be cause for reduction in the final grade.

There will be three (3) one hour tests as shown on the schedule. The tests will be composed of approximately one-half essay type questions and one-half objective questions. Each test will count 25% of the term grade.

A term paper will be required in lieu of a final examination and will count 25% of the term grade. The paper is to be 7-10 pages in length, typed and double spaced with references in an acceptable style. The paper may be on any topic of your choice relating to the technology of Europe of the U.S.A. for the period 1750-1914. Regardless of topic, the paper must include a discussion of the technology involved and its impact on the society of the period. It is suggested that you discuss your topic with the instructor before the due date of the term paper outline. The term paper is due at the scheduled class time.

Please note: The term paper will be graded on the mechanics of good writing (spelling, grammar, form, organization, etc.) as well as content. FURTHER, plagiarism in any form will not be tolerated and will be cause of a zero (0) grade on the work in question and possible failure of the course.

Some students may prefer to complete a model of a technological device from the period covered in the course in lieu of a term paper. This is acceptable subject to the prior approval of the instructor. The model must not be more than 18" square and 12" high and must be reasonably close to scale. It should be a working model whenever possible and must be accompanied by a 1-2 page description of the work. The model makers will be expected to present and describe the purpose and workings of these models to the class during the final week of the course.

Potential Term Paper Topics

These are but a few of the possible term papers that can be developed for this period of the History of Technology (1750-1914 in U.S.A. and Europe). They are provided to give you an idea of the type of paper subject you might choose - the list is not intended to be a limiting one.

The Develoment of the Steam-Powered Riverboat
The Early Development of the Petroleum Industry
The Sewing Machine
Gallatin and Early Transportaion
Canals: A Factor in the Westward Movement
Technology and the Public Lands
Early History of Land Reclamation in the West
The Business Innovations of Cyrus McCormick
The Truss Bridge
John Stevens and the Early Railroad in the U.S.A.
George Westinghouse
Tesla and the Power Industry
Hydraulic Power Development in the U.S.A.
The Railroad in the Civil War

Whitney, the Cotton Gin and the Civil War
Early City Planning in the U.S.A.
Otis and the Elevator
The Skyscraper and Related Engineering Problems
Street Sanitation in the 19th Century
Household Appliances
The Bicycle Age
Public Roads Movement Before World War I
Octave Chanute - Civil Engineer in the Development of Flight
Langley and the Airplane
Early Turnpikes
Frederick Olmsted and the American City
Jervis and the Old Croton Aqueduct
Municipal Transportation
Development of Waste Water Treatment Practices
Development of Engineering Education in the U.S.A.
John Stevens and the Panama Canal
Any Aspect of the Chemical Industry
Refrigeration: Its Development and Impact on Daily Life
Air Conditioning
Alexander Graham Bell's Contribution to Concepts of Flight
Great Structural Monuments in the U.S.A.
The Rubber Industry
Taylor and Scientific Management
Technology and Agriculture
Barbed Wire, Technology and the Frontier
The Development of Chemical Fertilizers
Tunnels and Tunnelling
Wedgewood and the Pottery Industry
Manufacture of Glass
Explosives
The Development of Labor Unions
Suez Canal
Carnot and Thermodynamics
German Chemical Industry
Engineering Education
The Great Lighthouses of the British Isles
Diderot and Industrial Development in France
Faraday and the Dynamo
Marconi and the Wireless
European Developments in Telegraphy
Swann and the Electric Light
The Design and Construction of the Crystal Palace
Food Preservation
The Internal Combustion Engine
European Developments in Flight
Richard Trevithick
George Hudson and Railway Investment
French Contributions to Engineering in the 18th Century
Sulfuric Acid as an Indication of Industrial Growth
Development and Industrial Usage of Chlorine

Suggested Model Projects

Cross-section of Britannia Bridge
Brunel's Tunnel Shield
Canal Lock
Blast Furnace
Early Version(s) of Lathe
Leyden Jar
Working Model of Early Telegraph Key
Suspension Bridge Model (of a specific bridge)
Working Model of Cotton Gin
Wright "Flyer"
Pelton Wheel

There are many other possibilities depending upon your interests, inclinations and handicraft skills. Please remember to check with the instructor for discussion and prior approval.

WARNING: Experience has indicated that it takes appreciable time to develop and complete a suitable and acceptable model project.

HIS 3471

History of Technology

TOPIC and ASSIGNMENT

Note, this class meets three times a week, Editor.

CLASS
SESSION

1. Introduction

   Derry and Williams, pp. 275-87.
   Morison, pp. 3-14.
   Sara R. Watson, "Civil Engineering History Gives Valuable Lessons," Civil Engineering (Special Issue) 47 (1977): pp. 14-17.

2. Early U.S. Inventors, Technologists and Scientists

   Gies and Gies, pp. 211-22.
   M. Hall, "From Ben to Benjamin," Harvard Magazine 77 (May 1975): 30-37, 53-54.

3. Early U.S. Inventors, Technologists and Scientists (continued)

   Gies and Gies, pp. 223-36.

4. Transportation - Role in I.R. and U.S. Development

   Derry and Williams, pp. 436-46.
   Morison, pp. 15-36.
   "Chesapeake & Ohio Canal," APWA Reporter (November 1974): 22-23.

5. Transportation - Role in I.R. and U.S. Development (continued)

Morison, pp. 37-46.
W. B. Lanbein, "Our Grand Erie Canal," Civil Engineering (Special Issue) 47 (1977): 61-66.

6. Transportation - Role in I.R. and U.S. Development (continued)

Derry and Williams, pp. 429-36.
H. Belloc, The Road (New York: Harper & Brothers, undated): 179-93.

7. Transportation - Role in I.R. and U.S. Development (continued)

J. H. Schaub, "The Kings Road: A National Historical Landmark," American Society of Civil Engineers, Engineering Issues 103 (July 1977): 217-22.
G. W. Scott-Giles, The Road Goes On (London: The Epworth Press, 1946), pp. 167-89.

8. Machine Tools and Mechanization

Derry and Williams, pp. 343-57.
Gies and Gies, pp. 237-50.

9. Machine Tools and Mechanization (continued)

Gies and Gies, pp. 251-75.

10. Machine Tools and Mechanization (continued)

Gies and Gies, pp. 276-92.

11. Machine Tools and Mechanization (continued)

E. E. Lampard, "The Social Impact of the Industrial Revolution," M. Kranzberg and C. Pursell, eds., Technology in Western Civilization (New York: Oxford University Press, 1967), I: 302-21.

12. TEST #1

13. Development and Growth of Railroads

Derry and Williams, pp. 457-62, 446-48.

14. Development and Growth of Railroads (continued)

Morison, pp. 47-59, 68-81.

15. Development and Growth of Railroads (continued)

D. Brown, Hear That Lonesome Whistle Blow (New York: Holt, Rinehart and Winston, 1977), pp. 272-83.
Anon., "Engineers and Navigators," British History Illustrated, Railway Special 1825-1975, (London, England, 1975), pp. 33-41.

16. Development and Growth of Railroads (continued)

17. Bridges, Engineering Mechanics and Growth of Engineering

Derry & Williams, pp. 448-57.
J. Gies, *Bridges and Man* (New York: Doubleday & Company, Inc., 1963), pp. 303-22.
M. H. Sawyer, "World's First Iron Bridge," *Civil Engineering* (December 1979): 46-49.

18. Bridges, Engineering Mechanics and Growth of Engineering (continued)

Gies and Gies, pp. 293-303, 304-15.
J. W. Williams, "James B. Eads and His St. Louis Bridge," *Civil Engineering* (Special Issue) (1977): 42-46.

19. Bridges, Engineering Mechanics and Growth of Engineering (continued)

Gies and Gies, pp. 316-24.

20. Bridges, Engineering Mechanics and Growth of Engineering (continued)

S. B. Hamilton, "Mechanics in Theory and Practice," *The Chartered Mechanical Engineer* 14 (April 1967): 158-64.
B. Warburton, "Eaton Hodgkinson," *The Chartered Mechanical Engineer* 21 (October 1974): 81-84.
A. I. Smith, "Sir William Fairbairn," *The Chartered Mechanical Engineer* 21 (May 1974): 78-80.

21. Iron Ships and Colonialism

Derry & Williams, pp. 364-77.

22. Iron Ships and Colonialism (continued)

A. Pugsley, ed., *The Works of Isambard Kingdom Brunel* (London: Institution of Civil Engineers, 1976), pp. 137-62.

23. Discussion

24. TEST #2

25. Chemical Industry

Derry and Williams, pp. 259-72, 506-14.

26. Chemical Industry (continued)

Derry and Williams, pp. 531-46.

27. The City

Morison, pp. 56-67.
D. L. Lankton, "Old Croton Aqueduct," *Civil Engineering*

(Special Issue) 47 (1977): 21-24.
C. M. Green *The Rise of Urban America* (London: Hutchinson & Co., Ltd., 1966), pp. 82-99.

28. The City: Public Health

M. Harrison, *London Beneath the Pavement* (London: Peter Davies, 1961), pp. 63-79.

29. The City: Public Health (continued)

J. C. O'Connell, "Chicago's Quest for Pure Water," Public Works Historical Society, Essay No. 1, June 1976.
J. Tarr, and F. McMichael, "Historical Turning Points in Municipal Water Supply," *Civil Engineering* (Special Issue) 47 (1977): 25-29.

30. The City: Skyscraper

G. Dallaire, "Birth of Skyscraper," *Civil Engineering* (Special Issue) 47 (1977): 47-50.

31. Age of Electricity

Gies and Gies, pp. 325-40.
M. Wilson, "Joseph Henry," *Scientific American* (issue unknown), pp. 73-77.

32. Age of Electricity (continued)

Gies and Gies, pp. 341-57.
Derry and Williams, pp. 621-29.

33. Age of Electricity (continued)

Gies and Gies, pp. 358-69.
Derry and Williams, pp. 629-35.

34. Age of Electricity (continued)

TERM PAPER OUTLINE DUE
J. J. O'Neill, "Tesla and Alternating Current," in S. Rapport and H. Wright, eds., *Engineering* (New York: New York University Press, 1963), pp. 297-312.

35. Bicycle and Automobile

A. Nevins, and F. E. Hill, *Ford* Vol. I *The Times, the Man, the Company* 1954. Reprint ed. (New York: Arno Press. 1973), pp. 92-102.
J. Rae, *The American Automobile* (Chicago: The University of Chicago Press, 1965), pp. 53-68.

36. Bicycle and Automobile (continued)

R. M. Wik, *Henry Ford and Grass-Roots America* (Ann Arbor: The University of Michigan Press, 1972), pp. 14-33.

37. Automobile and Change

38. Flight

39. Flight (continued)

C. H. Gibbs-Smith, "The Wright Brothers," (London: Her Majesty's Stationary Office), pp. 2-12.

40. Flight (continued)

T. D. Crouch, A Dream of Wings (New York: W. W. Norton & Company, 1981), pp. 284-305.

41. Discussion

42. TEST #3

43. New Materials

Derry and Williams, pp. 403-11, 413-18.

44. New Materials (continued)

45. PROJECTS AND TERM PAPERS DUE.

TECHNOLOGY AND CIVILIZATION HONORS SEQUENCE

W. David Lewis

Department of History
Auburn University
Alabama

History 274-275-276 is a sequence of three courses examining the connections between science, technology, and other aspects of human culture from prehistoric beginnings to the present time, with some speculation at the end of the third course concerning possible future trends and developments. It is an Honors Sequence, designed particularly for students majoring in scientific and technological disciplines; enrollment is by invitation only to entering freshmen whose A.C.T. and S.A.T. scores give promise of high performance. Development of the sequence was made possible by a grant from the National Endowment for the Humanities. The sequence is team-taught by a committee headed by Dr. W. David Lewis, Hudson Professor of History and Engineering. The other members are Dr. Guy V. Beckwith, Department of History; Dr. Margaret Kouidis, Department of English; Dr. John W. Kuykendall, Department of Religion; Dr. Michael S. Littleford, Department of Foundations of Education; and Dr. Raj P. Mohan, Department of Sociology and Anthropology.

The aim of the sequence is to expose students to a variety of perspectives regarding the role of science and technology in the development of human culture. The opening weeks of the first course, History 274, explore conflicting interpretations regarding the emergence of human intelligence, symbolization, notation, reckoning, speech, art, and ritual. Successive weeks examine the beginnings of agriculture, the rise of urban civilizations, and the role played by pastoral nomadism in the development of the ancient world. The final weeks of the course lay heavy emphasis upon the contributions of Greek Civilization to the emergence of a distinctive Western consciousness, and, to a lesser extent, upon the technological and other achievements of Roman culture.

History 275 is particularly concerned with the development of Western Civilization from the late Middle Ages onward, with emphasis upon the rise of modern science and industrialism. It examines conflicting views concerning the emergence of a mechanist and dualistic view of reality and a predominantly exploitative attitude toward the natural environment. During the early weeks of the course, attention is focused upon technological developments in the late Middle Ages, particularly the development of the mechanical clock and its use as a paradigm of the physical universe; the declining importance of other-worldly considerations in the European mind; and the emergence of the cultural phenomenon known as the Renaissance. Later weeks examine the birth of modern astronomy, the rise of the experimental method, the development of the Cartesian outlook, and the progress of industrialism in Western Europe. The final weeks of the course trace the development of the factory system and protests against it; the rise of imperialism; the unsettling influence of Darwinism and the Laws of Thermodynamics upon the late Nineteenth Century European mind; and the appearance of periodic economic crises, totalitarianism, and worldwide wars in the Twentieth Century.

History 276 is especially devoted to examining the development, since the early Seventeenth Century, of a series of non-mechanist challenges to the Cartesian, mechanist view of reality that gradually became predominant in modern scientific and industrial society. Early weeks of the course explore the non-mechanist views of the Italian philosopher Giambatista Vico; the emergence of European Romanticism, with particular attention to such figures as Rousseau, Wordsworth, Blake, Shelley, and Hegel; and the "Transcendentalist" thought of such Americans as Emerson and Whitman. Later weeks of the course explore a number of scientific and technological developments which contributed in one way or another to the emergence of a holistic view of reality, with special attention to the development of electricity, depth psychology, atomic physics, and cybernetics. The course concludes with an examination of two opposing views of the human future: a "High Tech" view stressing an intensification of the trends which have dominated the past several centuries, and a "Soft Tech" view advocating a less exploitative and a more nurturing attitude toward the physical environment, accompanied by a more "participatory" view of the place of humankind in nature rather than the objectification and dualism that has so strongly characterized mechanist thought.

Other Information About the Sequence

Classes meet for fifty minutes, three days per week. Ordinarily, two of these days will be devoted to lectures on readings and related material; these will be delivered by various members of the team teaching the courses, normally Dr. Lewis, but, in various cases, by members having special interests in specific subjects. The third meeting of each week will normally be divided between discussing the reading material and lectures and taking a short weekly quiz designed to test comprehension of the material presented.

An essential feature of the course is the gaining of experience in research and writing. Toward this end, there is a special exercise each quarter designed to proceed in an orderly way toward the writing of a Term Paper in the Spring Quarter. During the Fall Quarter, students are responsible for preparing a "Portfolio" of materials pertaining to a given subject involving ancient technology; the aim here is simply to become familiar with gathering information. During the Winter Quarter, students are responsible for preparing an "Annotated Bibliography" of materials on a given subject, which may either be completely different from the previous "Portfolio" subject or a continuation of that subject carried on into the period covered by History 275. During the Spring Quarter, students are responsible for preparing a full-fledged Term Paper on a subject relevant to some aspect of the material covered in the sequence.

Quizzes, Examinations, Grading

As previously indicated, quizzes are normally given each week to test comprehension of course material. There are eight of these each term; at the end of the term the three lowest quiz grades are dropped. The average grade of the remaining five constitutes one of the four major determinants of the final course grade. The second major determinant is the grade achieved in a fifty-minute midterm examination; the third is the grade achieved in a two-and-one-half-hour final examination at the end of the course; and the fourth is the grade awarded the Portfolio, Annotated Bibliography, or Term Paper, depending upon the quarter involved. Participation in class discussions can positively affect the final grade, particularly in "borderline" cases.

The following is a list of the topics and reading assignments that make up the three-course sequence.

TECHNOLOGY AND CIVILIZATION HONORS SEQUENCE

Fall Quarter: History 274

Week 1: Origins of Human Intelligence, Tool Use, and Symbolization

N. K. Humphrey, "The Origins of Human Intelligence," *Human Nature* 7 (December 1978): 42-47.

Sherwood Washburn, "Tools and Human Evolution," *Scientific American* 203 (September 1960): 63-75.

Leslie White, *The Science of Culture: A Study of Man and Civilization* (NY: Farrar, Straus, 1949), Chapter II: "The Symbol: The Origin and Basis of Human Behavior," pp. 22-39, and Chapter III: "On the Use of Tools by Primates," pp. 40-48.

Week 2: Origins of Communication, Speech, and Ritual

Charles D. Hockett, "The Origin of Speech," *Scientific American* 203 (September 1960): 89-96.

Lewis Mumford, *The Myth of the Machine: Technics and Human Develoment* (NY: Harcourt, Brace & World, 1967), Chapter III: "In the Dreamtime Long Ago," pp. 48-71.

Week 3: Hunting, Gathering, and the Origins of Art and Notation

Alexander Marshack, "Exploring the Mind of Ice Age Man," *National Geographic* 147 (January 1975): 62-89.

Lewis Mumford, *The Myth of the Machine: Technics and Human Development*, Chapter V: "Finders and Makers," pp. 98-125.

Week 4: The Agricultural Revolution and Matriarchal Religion

Robert J. Braidwood, "The Agricultural Revolution," *Scientific American* 203 (September 1960): 130-48.

Lewis Mumford, *The Myth of the Machine: Technics and Human Development*, Chapter VI: "Fore-Stages of Domestication," pp. 126-41, and Chapter VII, "Garden, Home, and Mother," pp. 142-62.

Rosemary Reuther, *New Woman, New Earth* (NY: Seabury Press, Inc. 1978), Chapter I: "The Descent of Woman," pp. 3-19.

Week 5: The Origin of Cities, Divine Kingship, and the Megamachine

Robert M. Adams, "The Origin of Cities," *Scientific American* 203 (September 1960): 153-65.

Lewis Mumford, *The Myth of the Machine: Technics and Human Development*, Chapter VIII: "Kings as Prime Movers," pp. 163-87, and Chapter IX: "The Design of the Megamachine," pp. 188-211.

Week 6: Nomadism and Patriarchal Religion

John Flight, "The Nomadic Idea and Ideal in the Old Testament," *Journal of Biblical Literature*, 42 (1923): 158-63 and 209-24.

Norman Gottwald, "Were the Early Israelites Pastoral Nomads?" in Jared Jackson and Martin Kessler, eds., *Rhetorical Criticism: Essays in Honor of James Muilenberg* (Allison Park, PA: Pickwick, 1974), pp. 251-55, with precis of the rest of the article written by John W. Kuykendall.

Carol Ochs, Behind the Sex of God: Toward a New Consciousness (Boston: Beacon Press, 1977), Chart from Chapter IV.

Marshall Sahlins, Tribesmen (Englewood Cliffs, NJ: Prentice-Hall, 1968), section on "Pastoral Nomadism," pp. 32-39.

Frank Trippett and Editors of Time-Life Books, The First Horsemen (NY: Time-Life Books, 1974), Chapter I: "The Magnificent Marauders," pp. 8-39.

Week 7: Early Greek Culture and Institutions

Norman O. Brown, Hermes the Thief, (Madison: University of Wisconsin Press, 1946), Chapter II: "Tribal Customs," pp. 33-46

William McNeill, The Rise of the West: A History of the Human Community (Chicago: University of Chicago Press, 1963), Chapter V, Section C: "The Formulation of Greek Civilization," pp. 188-217.

Excerpts from writings of early Greek philosophers: Heraclitus and Democritus.

Week 8: Greek Civilization and Institutions in the Golden Age

W. G. Hardy, The Greek and Roman World (Cambridge, MA: Schenkman, 1970), Chapter IV: "The World's First Democracy," pp. 8-11; Chapter V: "The Greeks as Writers and Athletes," pp. 11-13; and Chapter VI: "The Torch of Greek Thought," pp. 13-16.

William McNeill, The Rise of the West, Chapter 6: "The Expansion of Hellenism, 500-146 B.C.," pp. 254-94.

Excerpts from Aristotle, Politics and The Generation of Animals and Plato, "The Parable of the Cave."

Week 9: Hellenistic Technology and Culture

Henry Hodges, Technology in the Ancient World (NY: Knopf, 1972), Chapter 7: "The Late Greek and Roman Engineers and Their Devotion to Machinery," pp. 208-41.

Friedrich Klemm, A History of Western Technology (Cambridge, MA: MIT Press, 1964), Part I: "Graeco-Roman Antiquity," pp. 17-52.

Week 10: Roman Technology and Culture

W. G. Hardy, The Greek and Roman World, Chapter 7: "The Roman World," pp. 16-18; Chapter 8: "The Romans at Work and Play," pp. 18-21; Chapter 9: "Roman Luxury and Poverty," pp. 21-23; and Chapter 10: "Why Rome Fell," pp. 23-26.

TECHNOLOGY AND CIVILIZATION HONORS SEQUENCE

Winter Quarter: History 275

Note: All assignments are mandatory except for those which are specifically indicated to be optional.

Week 1: Late Medieval Technology, Cathedrals, and Mechanical Clocks

Lewis Mumford, *The Myth of the Machine: Technics and Human Development*, Chapter XII, Section 1: "The Benedictine Blessing," pp. 263-67; Section 2: "The Multiplication of Machines," pp. 267-69; Section 3: "Machines for Leisure," pp. 270-72; and Section 4, "The Medieval Equilibrium," pp. 272-74.

Lewis Mumford, *Technics and Civilization* 1934 (NY: Harcourt, Brace & World, 1963), Chapter I: "Cultural Preparation," pp. 9-59.

Arnold Pacey, *The Maze of Ingenuity* (NY: Holmes & Meier, 1975), Chapter I: "The Cathedral Builders," pp. 25-55 (optional), and Chapter II: "A Century of Invention," pp. 67-74.

Week 2: The Decline of the Medieval World-View and the Birth of Modern Attitudes in the Era of the Renaissance

J. Huizinga, *The Waning of the Middle Ages* (NY: St. Martin, 1924), Chapter I: "The Violent Tenor of Life," pp. 9-31 and Chapter II: "Pessimism and the Ideal of the Sublime Life," pp. 31-56.

John Herman Randall, Jr., *The Making of the Modern Mind* (NY: Houghton Mifflin, 1954), Chapter VI: "The New Interests of the Modern Age," pp. 111-41.

Week 3: Beginnings of the Scientific Revolution

J. Bronowski and Bruce Mazlish, *The Western Intellectual Tradition from Leonardo to Hegel* (NY: Harper, 1960), Chapter I: "Leonardo and His Times," pp. 3-19, and Chapter VII: "The Scientific Revolution," pp. 107-26.

Lewis Mumford, *The Pentagon of Power* (NY: Harcourt, Brace & Jovanovich, 1970), Chapter II: "Return of the Sun God," pp. 28-50, and Chapter III, "The Mechanized World Picture," pp. 51-104.

Lynn White, Jr., *Dynamo and Virgin Reconsidered: Machina ex Deo: Essays in the Dynamism of Western Culture* (Cambridge, MA: MIT Press, 1971), Chapter VI: "The Context of Science," pp. 95-105 (optional).

Week 4: Descartes, Newton, and the Triumph of Mechanism

J. Bronowski and Bruce Mazlish, *The Western Intellectual Tradition from Leonardo To Hegel*, Chapter X: "The Royal Society," pp. 180-92; Chapter XI: "Hobbes and Locke," pp. 193-215; and Chapter XII: "The Method of Descartes," pp. 216-29.

Herbert Butterfield, "The Scientific Revolution," *Scientific American* 203 (September 1960): 173-92 (optional).

Lewis Mumford, *The Pentagon of Power*, Chapter IV: "Political Absolutism and Regimentation," pp. 77-104.

Week 5: Background of the Industrial Revolution

Lewis Mumford, *Technics and Civilization*, Chapter II: "Agents of Mechanization," pp. 60-106, and Chapter III: "The Eotechnic Phase," pp. 107-50.

Week 6: The Triumph of the Industrial Revolution

J. Bronowski and Bruce Mazlish, *The Western Intellectual Tradition from Leonardo to Hegel*, Chapter XVII: "The Industrial Revolution," pp. 307-22, and Chapter XVIII: "The Lunar Society: Businessmen and Technicians," pp. 323-35.

Charles Dickens, *Hard Times* (NY: Bantam Classics, 1981), Chapters I through V.

Lewis Mumford, "Technics and Civilization", Chapter IV: "The Paleotechnic Phase," pp. 151-211.

Week 7: The Factory System, Owen, and Marx

J. Bronowski and Bruce Mazlish, *The Western Intellectual Tradition from Leonardo to Hegel*, Chapter XXV: "Robert Owen," pp. 450-71.

Karl Marx, *Capital* (NY: Modern Library, 1936). Reprint ed. (NY: Random House, 1977), Vol 1, Chapter XV: "Machinery and Modern Industry," pp. 430-78. Pagination from original edition.

Arnold Pacey, *The Maze of Ingenuity*, Chapter VIII: "Liberty, Utility, and Socialism: Social Ideals During the Industrial Revolution," pp. 235-61 (Optional).

Week 8: Imperialism and the Spread of the Industrial Revolution

Joseph Conrad, *Heart of Darkness* (NY: Norton, 1971), (complete).

Daniel Headrick, *The Tools of Empire: Technology and European Imperialism in the Nineteenth Century* (NY: Oxford University Press, 1981), Chapter III: "Malaria, Quinine, and the Penetration of Africa," pp. 58-76; Chapter VII: "Arms Gap and Colonial Confrontations," pp. 115-24; and Chapter XV, "The Legacy of Technological Imperalism," pp. 204-10.

I. Robert Sinai, *The Challenge of Modernisation* (NY: Norton, 1964), Chapter II: "Imperialism and Its Consequences," pp. 47-58.

Week 9: Darwinism, and the Laws of Thermodynamics, and the *Fin-de-Siecle* Spirit

Henry Adams, *The Degradation of the Democratic Dogma* (NY: Macmillan Company, 1919), pp. 140-59 (optional).

Donald Fleming, "Charles Darwin, the Anaesthetic Man," in Philip Appleman, ed., *Darwin* (NY: Norton, 1979), pp. 573-89.

Mark Hillegas, *The Future as Nightmare: H. G. Wells and the Anti-Utopians* (NY Oxford University Press, 1967), Chapter II, pp. 16-39.

Cynthia Eagle Russett, *Darwin in America* (San Francisco: W. H. Freeman, 1976), Chapter I: "Origins," pp. 1-22.

H. G. Wells, *The Time Machine* (Cambridge, MA: R. Bentley, 1971), Chapter XI.

Week 10: Mass Production, Depression, and Total War

Raymond Aron, *The Century of Total War*, (Westport, CT: Greenwood, 1981), Chapter I: "The Technical Surprise," pp. 9-31, and Chapter II: "Dynamism of Total War," pp. 32-43.

John B. Rae, "The Rationalization of Production," in Melvin Kranzberg and Carroll Pursell, eds., *Technology in Western Civilization* (NY: Oxford University Press, 1967), Vol. II, pp. 37-52 (optional).

Herbert J. Spiro, "Totalitarianism," in David L. Sills, ed., *Encyclopedia of the Social Sciences* (NY: Macmillan, 1968), Vol. 16, pp. 106-13.

Studs Terkel, *Hard Times: An Oral History of the Great Depression* (NY: Pantheon Books, 1970), "Honor and Humiliation," pp. 419-38. Optional: "The Big Money," pp. 60-81 and "Sixteen Ton," pp. 198-212.

Robert G. L. Waite, "Adolf Hitler: A Life Sketch," abridged from William D. Halsey, ed. dir., *Collier's Encyclopedia* (NY: Macmillan Educational Corporation, 1976), Vol. 12, pp. 158-61.

TECHNOLOGY AND CIVILIZATION HONORS SEQUENCE

Spring Quarter: History 276

Week 1: The Philosophy of Giambattista Vico

Selections from Vico's Autobioraphy (Ithaca, NY: Cornell University Press; 1944), New Science (Ithaca, NY: Cornell University Press; 1968), and On the Study Methods of Our Time, (Indianapolis, IN: Bobbs-Merrill, 1965).

Stuart Hampshire, "Vico and the Contemporary Philosophy of Language," from Giorgio Tagliacozzo, ed., Giambattista Vico: An International Symposium (Baltimore, MD: Johns Hopkins Press, 1969), pp. 475-81.

Michael S. Littleford, "Vico and Curriculum Studies," Journal of Curriculum Theorizing 1 (Summer 1979): 54-64.

Robert Pirsig, Zen and the Art of Motorcycle Maintenance (NY: William Morrow & Co., 1974), pp. 232-42.

Week 2: The Romantic Revolt

J. Bronowski and Bruce Mazlish, The Western Intellectual Tradition from Leonardo to Hegel, Chapter XVI: "Rousseau," pp. 280-304.

H. G. Schenck, The Mind of the European Romantics (NY: Oxford University Press, 1979), Chapter I: "Reaction against Rationalism," pp. 3-8, and Chapter XVII: "Nature Mysticism," pp. 162-76. Optional: Chapter II: "Progress and Disenchantment," pp. 8-14; Chapter IV: "Quest for Reintegration," pp. 22-30; and Chapter XXI: "Redemption through Music," pp. 201-32.

June Singer, The Unholy Bible: A Psychological Interpretation of William Blake (New York: G. P. Putnam's Sons, 1970), Chapter II: "The First Half of Life," pp. 14-38.

Selections from poetry of Blake ("The Tyger" and other poems) and Wordsworth ("Ode, Intimations of Immortality").

Week 3: Electricity and the Communications Revolution, with some Emphasis on the Role of Electricity in the Thinking of Non-Mechanists from Shelley to McLuhan.

Bern Dibner, "The Beginning of Electricity" and "Communications" in Kranzberg and Pursell, eds. Technology in Western Civilization I, pp. 437-68. Optional: Harold I. Sharlin, "Applications of Electricity" and "Electrical Generation and Transmission," in Ibid., pp. 563-92.

Lewis Mumford, Technics and Civilization, Chapter V: "The Neotechnic Phase," pp. 212-29 and 239-50.

W. David Lewis, Précis on Carl Grabo, A Newton Among Poets: Shelley's Use of Science in Prometheus Unbound (Staten Island, NY: Gordian Press, Inc. 1968), Chapter VIII: "Electricity the Spirit of the Earth," pp. 118-38, and Chapter IX: "Electrical Theory of Matter," pp. 139-58.

Week 4: The Philosophy of Hegel

J. Bronowski and Bruce Mazlish, The Western Intellectual Tradition from Leonardo to Hegel, Chapter XXVI: "Kant and Hegel: The Emergence of History," pp. 472-90.

Frederick Copleston, A History of Philosophy (London: Burns, Dates, & Washbourne, 1966), Vol. VII, Chapter IX: "Hegel," pp. 194-97.

Selections from G. W. F. Hegel, "Reason in History," Introduction to Lectures on the Philosophy of World History (NY: Cambridge University Press, 1975), and Carl J. Friedrich, ed., The Philosophy of Hegel (NY: Modern Library, 1965).

Week 5: Transcendentalism and the Emergence of Depth Psychology

Joseph Campbell, ed., The Portable Jung (NY: Viking Press, 1971), "Editor's Introduction," pp. vii-xxxii.

Ralph Waldo Emerson, Essay on "The Over-Soul," in The Essays of Ralph Waldo Emerson (NY: Heritage Press, 1934).

Floyd W. Matson, The Broken Image: Man, Science, and Society (NY: G. Braziller, 1964), Chapter VI, sections on "Freud: Romantic Mechanist," pp. 180-91 and "The Dialectics of Becoming: C. G. Jung," pp. 194-201.

Selections from Walt Whitman's "A Song of Myself," in Complete Poetry and Collected Prose (NY: Literary Classics of the U.S., Viking Press, 1982).

Week 6: The Emergence of the Atomic Age

Ronald Clark, The Scientific Breakthrough (NY: Putnam, 1974), Chapter V: "The Nuclear Revolution," pp. 146-81.

Fritjhof Kapra, The Tao of Physics: An Exploration of the Parallels Between Modern Physics and Eastern Mysticism (Boulder, CO: Shambhala Publishers, Inc. 1975), Chapter IV: "The New Physics," pp. 52-81.

Floyd W. Matson, The Broken Image: Man, Science, and Society, Chapter IV: "An Uncertain Trumpet: The New Physics," pp. 113-40.

Week 7: The Computer and the Question of Artificial Intelligence

Christopher Evans, The Micro Millennium (NY: Viking Press, 1980), Chapter XII: "The Nature of Intelligence," pp. 155-73; Chapter XIII: "Can A Machine Think?" pp. 174-89; and Chapter XIV: "Towards the Ultra-Intelligent Machine," pp. 190-98.

Martin O. Holoien, Computers and Their Social Impact (NY: Wiley, 1977), Chapter I: "A History of Computational Devices," pp. 1-28, and Chapter II: "Twentieth Century Computational Machines," pp. 30-47.

Charles J. Sippl and Robert Bullen, Computers at Large, (Indianapolis: Bobbs-Merrill, c. 1976), Chapter 00100: "The Robots are Coming--and Giants too," pp. 147-70.

Week 8: A "High-Tech" Look at the Future

Gerard O'Neill, The High Frontier: Human Colonies in Space (NY: William Morrow & Co. 1977), Chapter VIII: "The First New World," pp. 115-64.

Alvin Toffler, The Third Wave (NY: Morrow, 1980), Chapter XV: "Beyond Mass Production," pp. 179-93, and Chapter XVI: "The Electronic Cottage," pp. 194-207.
Alvin M. Weinberg, "Can Technology Replace Social Engineering?" in Noel de Nevers, ed., Technology and Society (Reading, MA: Addison Wesley, 1972), pp. 171-79.

Week 9: A "Soft-Tech" Look at the Future

Harvey Cox, The Seduction of the Spirit (NY: Simon and Schuster, 1973), Chapter VIII: "Naked Revival: Theology and the Human Potential Movement," pp. 197-225.
Willis Harman, An Incomplete Guide to the Future (NY: Norton, 1979), Chapter VII: "The Changing Image of Man," pp. 89-111, and Chapter VIII: "The Transindustrial Era," pp. 113-33 (optional).
Theodore Roszak, Person/Planet (Garden City, NY: Anchor Press, Doubleday, 1978), Chapter X: "When Empires Fall," pp. 285-303.
Philip Slater, The Pursuit of Loneliness (Boston: Beacon Press, 1970), Chapter IV: "Putting Pleasure to Work," pp. 81-95 (optional).
William I. Thompson, Passages About Earth (NY: Harper & Row, 1981), Chapter VII: "To Findhorn and Lindisfarne," pp. 150-83.

HISTORY OF TECHNOLOGY

Howard P. Segal

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This course has three principal objectives:

1. to acquaint students with major developments in the history of Western technology, particularly from the period 1750 to the present, the period of the most extensive technological developments;
2. to evaluate the variety of conceptions of "technology," of "technological change," and of "technological society;"
3. to examine the relationships between technological change and social change in both the past and the present.

The course assumes no familiarity with the history of technology and welcomes the participation of students from non-technical and technical backgrounds alike. The course will examine the history of technology both "internally"--that is, tools, machines, and structures themselves--and "externally"--that is, their relationship to the societies which have produced them and upon which they in turn have had impact. The course will also integrate theoretical readings with historical and technical ones.

Required book purchases:

- Melvin Kranzberg and Carroll W. Pursell, Jr., eds., *Technology in Western Civilization*, Vol. 1 (NY: Oxford Univ. Press, 1967).
- Jean Gimpel, *The Medieval Machine* 1976. Paper ed. (NY: Penguin, 1977).
- John G. Burke and Michael C. Eakin, eds., *Technology and Change* (San Francisco: Boyd and Fraser, 1979).

Recommended book purchases: one of these four:

- John Ellis, *The Social History of the Machine Gun* 1973. Paper ed. (NY: Pantheon, 1975).
- Harold C. Livesay, *Andrew Carnegie and the Rise of Big Business* (Boston: Little, Brown, 1975).
- James J. Flink, *The Car Culture* (Cambridge, MA: MIT, 1976).
- Michel Crozier, *The World of the Office Worker* (NY: Schocken, 1973).

Course requirements:

Three written assignments, 2 short papers and 1 final examination. Quality of writing as well a quality of analysis will determine grades for papers. Both short papers must be typed. The first paper will be a review of Gimpel's Medieval Machine. The second paper will be a review of one of the four recommended books.

Regular class attendance is expected, but regular class participation will only raise overall grades, not lower them. There will be occasional quizzes in class, to be graded on a pass-fail basis, to test understanding of the reading assignments.

For the purpose of better acquainting students with the physical dimensions of modern technology there will be a class tour of both the Henry Ford Museum and the Ford Rouge Plant in Dearborn sometime during the semester. Prior to the tour there will be a class discussion of an essay by historian George Basalla, "Museums and Technological Utopianism," copies of which will be distributed in class.

Course topics and reading are listed below. All readings are in the books either required or recommended for purchase. They are listed in order of assignment.

1. THE NATURE OF TECHNOLOGY: AN OVERVIEW AND CONTRASTING VIEWS

Melvin Kranzberg and Carroll W. Pursell, Jr., "The Importance of Technology in Human Affairs," in Technology in Western Civilization (hereafter cited as TIWC), ch. 1.
Jacques Ellul, "The Technological Order," in Technology and Change (hereafter cited as TAC), pp. 13-19.
Samuel C. Florman, "In Praise of Technology," in TAC, pp. 21-30.
Barry Commoner, "Are We Really in Control?" in TAC, pp. 6-9.

2. THE ORIGINS OF TECHNOLOGY AND OF SOCIETY

R. J. Forbes, "The Beginnings of Technology and Man," and "Mesopotamian and Egyptian Technology," in TIWC, chs. 2 & 3 (skip pp. 28-43 of ch. 3).
Peter Drucker, "The First Technological Revolution and Its Lessons," in TAC, pp. 39-46.

3. TECHNOLOGY AND SOCIETY FROM CLASSICAL TO EARLY MODERN TIMES

A. G. Drachmann, "The Classical Civilizations," in TIWC, ch. 4.
Lynn White, Jr., "Technology in the Middle Ages," in TIWC, ch. 5.
L. White, Jr., "The Act of Invention," in TAC, pp. 379-92.
A. Rupert Hall, "Early Modern Technology, to 1600," and "Cultural, Intellectual, and Social Foundations, 1600-1750," in TWIC, chs. 6 & 7.
Shepherd B. Clough, "Economic and Political Developments, 1600-1750," in TIWC, ch. 8.
G. E. Fussell, "The Agricultural Revolution, 1600-1850," in TIWC, ch. 9.

Silvio A. Bedini and Derek J. DeSolla Price, "Instrumentation," in TIWC, ch. 11.
Carlo M. Cipolla, "Clocks and Culture," in TAC, pp. 60-64.
STUDENT REPORTS: Jean Gimpel, The Medieval Machine.

4. THE INDUSTRIAL REVOLUTION

M. Kranzberg, "Prerequisites for Industrialization," in TIWC, ch. 13.
James Kip Finch, "Transportation and Construction, 1300-1800: The Rise of Modern Civil Engineering," in TIWC, ch. 12.
John B. Rae, "The Invention of Invention," in TIWC, ch. 19.
Abbott Payson Usher, "The Textile Industry, 1750-1830," in TIWC, ch. 14.
Eugene S. Ferguson, "The Steam Engine Before 1830," and "Metallurgical and Machine-Tool Developments," in TIWC, chs. 15 & 16.
C. Pursell, "Machines and Machine Tools, 1830-1880," in TIWC, ch. 23.
E. Ferguson, "Steam Transportation," in TIWC, ch. 17.
John G. Burke, "Bursting Boilers and the Federal Power," in TAC, pp. 356-67.
Georg Borgstrom, "Food and Agriculture in the Nineteenth Century," in TIWC, ch. 24.
Eric E. Lampard, "The Social Impact of the Industrial Revolution," in TIWC, ch. 18.
Hugo A. Meier, "Technology and Democracy, 1800-1860," in TAC, pp. 211-13.
Thomas A. Palmer, "Military Technology," in TIWC, ch. 29.
Rondo Cameron, "Imperialism and Technology," in TIWC, ch. 43, (skip pp. 695-701).
STUDENT REPORTS: John Ellis, The Social History of the Machine Gun.

5. THE GROWTH OF "TECHNOLOGICAL SOCIETY"

Bern Dibner, "Communications," in TIWC, ch. 27.
Thomas M. Smith, "Late Nineteenth-Century Communications," in TIWC, ch. 39.
Harold F. Williamson, "Mass Production for Mass Consumption," in TIWC, ch. 42.
Anthony N. B. Garvan, "Effects of Technology on Domestic Life, 1830-1880," in TIWC, ch. 33.
Siegfried Giedion, "Engineering the Household," in TAC, pp. 273-75.
Ruth S. Cowan, "The 'Industrial Revolution' in the Home," in TAC, pp. 276-82.
E. Ferguson, "Expositions of Technology, 1851-1900," in TIWC, ch. 44 (skip pp. 709-21).
Charles L. Sanford, "Technology and Culture at the End of the Nineteenth Century: The Will to Power," in TIWC, ch. 45 (skip pp. 730-36).
STUDENT REPORTS: Harold C. Livesay, Andrew Carnegie and the Rise of Big Business

6. FROM INDUSTRIAL TO POST-INDUSTRIAL SOCIETY IN AMERICA AND EUROPE: PROBLEMS AND PROSPECTS

Thorstein Veblen, "The Role of the Engineers," in TAC, pp. 283-89.
Robert H. Guest, "Scientific Management and the Assembly Line," in TAC, pp. 98-106.

Gary Brynner and Dan Clark, "Worker Alienation," in TAC, pp. 107-109.
Victor C. Ferkiss, "Bureaucracy," in TAC, pp. 86-91.
Lewis Mumford, "The All-Seeing Eye," in TAC, pp. 65-67.
Herbert Simon, "What Computers Mean for Man and Society," in TAC, pp. 68-76.
Simon Ramo, "The Systems Approach," in TAC, pp. 77-82.
Theodore Roszak, "The Citadel of Expertise," in TAC, pp. 83-85.
S. Husain Zaheer, "India's Need for Advanced Science and Technology," in TAC, pp. 193-97.
Wilson Clark, "Intermediate Technology," in TAC, pp. 198-202.
Donald E. Marlowe, "Public Interest--First Priority in Engineering Design?" in TAC, pp. 297-301.
Harvey Brooks, "Technology Assessment in Retrospect," in TAC, pp. 465-76.
STUDENT REPORTS: James J. Flink, The Car Culture.
STUDENT REPORTS: Michel Crozier, The World of the Office Worker.

Final Exam

In an essay of about 1,000 words, please answer either one of the following two sets of questions:

(1) In which ways was the industrial revolution which began in England in the mid-1700s similar to and different from the industrial revolution in Western Europe in the Middle Ages as described by J. Gimpel and L. White? Can both legitimately be called industrial revolutions? Provide several specific examples to support your arguments.

(2) Read Harvey Brooks' article, "Technology Assessment in Retrospect," in Technology and Change, pp. 465-76. In light of your examination of the history of technology, what other aspects, if any, about technology and its relationships with society ought to be taken into account in assessing technology in the past and in the present? What lessons, if any, about the course of technological development in the past can be drawn to apply to its present and even its future development? Provide specific examples to support your arguments.

Please type your exam if at all possible; otherwise, please print it neatly. Indicate which question you are answering. Please make and keep a copy of the final version.

TECHNOLOGY IN HISTORY

Jeffrey L. Sturchio

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This course is designed to provide an introduction to the history of Western technology from medieval agriculture to the second Industrial Revolution of the late-nineteenth century. The history of technology began as a series of instructive tales for engineers, a chronology of technical discovery and the progress of civilization. But along with increasing concern over the relationships of technology and society, a new interest in the field has emerged during the past twenty-five years. The history of technology has become more than just the history of invention; it now encompasses a variety of perspectives on technological change. Among the historical themes we will examine are the process of technological change, the nature of technological systems, the diffusion of technological improvements, the changing relations of science and technology, and the role of technology in broader historical movements (such as imperialism). Differing perspectives on the nature of technology --as a system of ideas, a means of production, or a social process-- will inform our discussion.

Course requirements include:

1. ASSIGNED READING: The four main texts for History 485 are:

   - Daniel R. Headrick, The Tools of Empire: Technology and European Imperialism in the Nineteenth Century (New York: Oxford University Press, 1981).
   - David S. Landes, The Unbound Prometheus: Technological Change and Industrial Development in Western Europe From 1750 to the Present (Cambridge: Cambridge University Press, 1969).
   - Arnold Pacey, The Maze of Ingenuity: Ideas and Idealism in the Development of Technology (Cambridge, MA: MIT Press, 1976).
   - Lynn White, Jr., Medieval Technology and Social Change (New York: Oxford University Press, 1962).

These books may be purchased in the NJIT bookstore. Along with other assigned readings, they will also be on reserve in Van Houten Library. Students should make every attempt to read assignments before the appropriate classes.

2. LECTURES AND DISCUSSIONS: In addition to doing the required reading, students are naturally expected to attend class and to take part in discussion of the material. For the day section, Friday classes will be reserved for questions and analysis of readings. On Mondays and Wednesdays, background lectures will normally precede class discussion. Lectures and discussion will be combined in evening sessions. Participation in class will be a factor in determining final grades for the course.

3. WRITTEN ASSIGNMENTS: Each student will prepare two papers. The first (3-6 typewritten pages) will be a critical review of a monograph in the history of technology. The second (10-12 typewritten pages) will be a

research paper on a particular invention, engineering project, or technological system. Further details on these assignments will be presented in class. The first paper will be due on October 14, the second on December 9. Written work will be judged on the basis of information content, clarity of style, and coherence of structure. Late papers will be penalized one-third of a grade per day.

4. EXAMINATIONS: A mid-term examination will be given during the week of October 26. The date and time of the final exam will be announced.

5. GRADES: The mid-term and short paper will each count for one-fifth (20%) of the final grade. The final exam and research paper will each count for 30%. Class participation will help in deciding borderline cases.

Some basic sources in the history of technology. The books, journals and bibliographies listed below will prove useful in selecting paper topics and finding further reading on subjects of interest.

I. *General histories*: For an encyclopedic survey of the field, see the seven-volume *History of Technology*, edited by Charles Singer, E.J. Holmyard, A.R. Hall, and T.I. Williams (Oxford: Clarendon Press, 1954-1958, 1978). The Oxford history is marred by its Anglocentric bias. T.K. Derry and T.I. Williams, *A Short History of Technology from the Earliest Times to A.D. 1900* (Oxford: Clarendon Press, 1960) is a handy condensation of the first five volumes. Less comprehensive but more instructive is the two-volume collection on *Technology in Western Civilization,* edited by M. Kranzberg and C. Pursell (New York: Oxford Univ. Press, 1967). Another useful compendium is the multi-volume *History of Technology and Invention*, edited by Maurice Daumas (New York: Crown, 1969-). For Chinese technology, see Joseph Needham's magisterial *Science and Civilization in China* (Cambridge: Cambridge Univ. Press, 1954-).

II. *Journals*: Basic journals in the field include *History of Technology*, *Technikgeschichte*, *Technology and Culture*, and the *Transactions of the Newcomen Society*. Articles of interest appear in a wide variety of other periodicals, e.g., *IA: Journal of the Society for Industrial Archeology*, *Business History Review*, and the *Journal of Economic History*.

III. *Bibliographies*: The standard bibliography is Eugene S. Ferguson, *Bibliography of the History of Technology* (Cambridge, MA: MIT Press, 1968). See also Carroll Pursell's chapter on "History of Technology," pp. 70-120, in Paul T. Durbin, ed., *A Guide to the Culture of Science, Technology, and Medicine* (New York: Free Press, 1980); Kenneth J. Rider, *History of Science and Technology: A Select Bibliography for Students*, second edition (London: Library Association, 1970); and the annual bibliographies of current work in *Technology & Culture*. Two French bibliographies are also helpful, even if one is not fluent in the language: F. Russo, *Elements de Bibliographie de l'Histoire des Sciences et des Techniques*, 2me ed. (Paris: Herman, 1969); and the quarterly *Bulletin Signaletique 522: Histoire des sciences et des techniques* (Paris: CNRS). Finally, the original version of David S. Landes's *Unbound Prometheus*, which was entitled "Technological Change and Industrial Development in Western Europe, 1750-1914," in H. J. Habakkuk and M. Postan, eds., *The Cambridge Economic History of Europe*, Vol. VI: *The Industrial Revolutions and After: Incomes, Population and Technological Change*, Pt. I (Cambridge: Cambridge University Press, 1965), pp. 274-601, included an extremely valuable bibliography in Part II, pp. 943-1007, deleted from the paperback edition.

READING LIST

Week

TOPIC

1. Introduction: Histories of Technology

   Pacey, Preface (unpaginated) and Introduction, pp. 13-21.
   Robert Heilbroner, "Do Machines Make History?" Technology and Culture 8 (July 1967): 335-45. Also in M. Kranzberg and W. Davenport, eds., Technology and Culture: An Anthology (New York: Meridian, NAL, 1972), pp. 29-40.
   Lynn White, Jr., "The Act of Invention: Causes, Contexts, Continuities, and Consequences," Technology and Culture 3 (Oct. 1962): 486-500. Also in White, Machina ex Deo (Cambridge, MA: MIT Press, 1968), pp. 107-31; and Kranzberg and Davenport, pp. 274-91.

2. Medieval Technology and Social Change

   White, pp. 1-134.

3. Cathedrals, Clocks, and Cosmologies

   Pacey, pp. 25-86.

4. Technologies of Early Modern Europe: Guns and Sails, Printing and the Book

   Pacey, pp. 87-115.
   Fernand Braudel, Capitalism and Material Life, 1400-1800 (New York: Harper & Row, 1973), pp. 285-324.

5. Technologies of Early Modern Europe: Metallurgy, Mining, and Mechanical Devices

   Pacey, pp. 144-73.
   Braudel, pp. 244-84.

6. The Changing Relations of Science, Technology, and the State

   Pacey, pp. 116-43, 174-203.
   Peter Mathias, "Who Unbound Prometheus? Science and Technical Change, 1600-1800," in Mathias, ed., Science and Society, 1600-1900 (Cambridge: Cambridge Univ. Press, 1972), pp. 54-80. Also in Mathias, The Transformation of England: Essays in the Economic and Social History of England in the Eighteenth Century (London: Methuen, 1979), pp. 45-71.

7. The Industrial Revolution in Britain: Textiles and Steam

   Landes, pp. 41-114.
   Pacey, pp. 204-34, 262-68.

8. The Industrial Revolution in Britain: Coal, Iron, and Chemicals

   Landes, pp. 41-114.
   Pacey, pp. 204-34, 262-68.

9. Factories, The Labor Force, and the Philosophy of Manufactures

   Landes, pp. 114-23.
   E. P. Thompson, "Time, Work-Discipline, and Industrial Capitalism," *Past and Present* No. 38 (December 1967): pp. 56-97.
   Pacey, pp. 235-61, 268-82.

10. The Diffusion of Technology: The Case of Steam Power

    Eric H. Robinson, "The Early Diffusion of Steam Power," *Journal of Economic History* 34 (March 1974): 91-107.
    Nathan Rosenberg, *Perspectives on Technology* (Cambridge: Cambridge Univ. Press, 1976), pp. 151-72, 189-210.

11. The Industrialization of Continental Europe: Entrepreneurs, Economic Growth, and Technological Change

    Landes, pp. 124-230.

12. The Industrialization of Continental Europe: Transportation, Communication, and the Mechanization of Industry

    Landes, pp. 124-230.

13. Technology and European Imperialism: Establishing Hegemony

    Headrick, pp. 3-126.
    Pacey, pp. 282-90.

14. Technology and European Imperialism: The Consolidation of Empire

    Headrick, pp. 129-210.

15. Technological Systems and the "Second" Industrial Revolution

    Landes, pp. 231-358.
    Pacey, pp. 293-301.

16. The Order of the Technological World

    Thomas Parke Hughes, "The Order of the Technological World," *History of Technology* 5 (1980): 1-16.
    Pacey, pp. 301-21.
    Lewis Mumford, "Authoritarian and Democratic Technics," *Technology and Culture* 5 (January 1964): 1-8. Also in Kranzberg and Davenport, pp. 50-59.
    Langdon Winner, "Do Artifacts Have Politics? *Daedalus* 109 (Winter 1980): 121-36.

SECTION II.

TECHNOLOGY IN AMERICAN HISTORY

TECHNOLOGY IN AMERICAN HISTORY

Jeffrey L. Sturchio

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Newark, New Jersey

This course, History 486, provides an introduction to the role of technology in American history. Like its companion, HIST 485, it begins with the assumption that the history of technology is not merely a chronicle of the invention of myriad machines and mechanical devices, but also involves systems of ideas, social interests, and institutional networks. While "nuts and bolts" are an undeniably important element in understanding the history of technology, we will emphasize the social and economic environment of technological change in America from roughly 1780-1950.

In the first half of the course, we will examine the transformation of the agrarian and mercantile economy of the colonial period to the industrial nation of the mid-nineteenth century. Case studies will include the importance of the transfer of technology in building cities and canals; the establishment of factories and changes in the organization of work; and the rise of the American system of manufactures. We will conclude our study of the industrialization of antebellum America with an exploration of the diffusion of mechanization, the increasing use of iron and steel, and the development of major technological systems like the railroad and the telegraph.

During the second half of the course, we will deal with the rise of big business in late nineteenth-century America and the concomitant professionalization of engineering practice. Topics will include the changing character of invention and innovation--especially the transition from independent inventors to corporate industrial research--and the connections between engineers and corporate capitalism. We will also investigate the social impact of new technological systems like the automobile and electric light and power in twentieth-century America.

Course assignments include:

1. ASSIGNED READING: Most assigned readings will be taken from the following books, all of which are available in the bookstore:

- Alfred D. Chandler, The Visible Hand: The Managerial Revolution in American Business (Cambridge, MA: Belknap Press, 1977).
- John F. Kasson, Civilizing the Machine: Technology and Republican Values in America, 1776-1900 (New York: Grossman/Viking, 1976).
- David F. Noble, American By Design: Science, Technology, and the Rise of Corporate Capitalism (New York: Knopf, 1977).
- Carroll Pursell, ed., Technology in America: A History of Individuals and Ideas (Cambridge, MA: MIT Press, 1981).
- Nathan Rosenberg, Technology and American Economic Growth (New York: Harper & Row, 1972). Reprint ed. (White Plains, NY: M.E. Sharpe, 1976). (Note: page numbes reflect original edition.)

- Merritt Roe Smith, Harpers Ferry Armory and the New Technology: The Challenge of Change (Ithaca, NY: Cornell University Press, 1977).

Copies of other required readings will be distributed in class. Students should make every effort to read assignments before the appropriate classes.

The reading list below also includes recommended readings for each week. These articles and books are intended as suggestions for those with both the interest and the energy who would like to delve further into the course material. This material amplifies themes covered in the required reading and provides further information on topics discussed in lectures.

Recommended readings may be found in Van Houten Library or obtained from the instructor.

2. LECTURES AND DISCUSSIONS: In addition to doing the assigned reading, students are naturally expected to attend class and to take part in discussion of the course material. On Mondays and Wednesdays, background lectures will normally occupy class time. Fridays will be reserved for questions and analysis of the required readings.

3. WRITTEN ASSIGNMENTS: Each student will prepare two critical book reviews of approximately 4-6 typewritten pages. Everyone will read the same book for the first review: M.R. Smith's Harpers Ferry Armory and the New Technology (1977). Suggestions for the second review, which will deal with a monograph in the history of American technology, will be handed out in due course.

The first book review is due on 12 March, the second on 30 April. Late papers will be penalized one-third of a grade per day.

4. EXAMINATIONS: There will be an in-class midterm on 5 March. The take-home final examination will be due during exam period, at the time officially scheduled for the HIST 486 final. Questions for the final will be distributed at least two weeks ahead of time.

5. GRADES: The mid-term and first paper will each count for one-fifth (20%) of the final grade. The final exam and second paper will each count for 30%. Class participation will help in deciding borderline cases.

6. FIELD TRIPS: The metropolitan Newark-New York area has been the site of many significant contributions to the history of American technology. HIST 486 will take optional field trips to three of these sites after the spring break: Edison's West Orange Laboratory, Paterson, and the Murray Hill campus of Bell Labs.

A Guide To Further Reading

The books, journals, and bibliographies listed below will prove useful in following up subjects of interest. These and the recommended readings are intended as an initial guide to the voluminous literature in the field.

I. Historiography: History is not just what really happened in the past, but something more elusive --what historians make of those events. Historians of technology have written a number of reflective essays on their craft. Among accounts of the nature of invention and technological knowledge, see Eugene S. Ferguson, "The Mind's Eye: Nonverbal Thought in Technology," *Science* 197 (26 August 1977): 827-36; Brooke Hindle, *Emulation and Invention* (New York: NYU Press, 1981): 127-42; and Edwin T. Layton, Jr., "Technology as Knowledge," *Technology and Culture* 15 (January 1979): 31-41. Recent reviews of the state of the art in the history of American technology include George H. Daniels, "The Big Questions in the History of American Technology," *Technology and Culture* 11 (January 1970): 1-21; and David A. Hounshell, "Commentary: On the Discipline of the History of American Technology," *Journal of American History* 67 (March 1981): 854-65. See also Eugene S. Ferguson, "Toward a Discipline of the History of Technology," *Technology and Culture* 15 (January 1974): 13-30; Thomas Parke Hughes, "Emerging Themes in the History of Technology," *Technology and Culture* 20 (October 1979): 697-711; and Hughes, "Convergent Themes in the History of Science, Medicine, and Technology," *Technology and Culture* 22 (July 1981): 550-58.

II. *General Histories*: For an encyclopedic survey of the field, see the seven-volume *History of Technology,* edited by Charles Singer, E.J. Holmyard, A.R. Hall, and T.I. Williams (Oxford: Clarendon Press, 1954-1958, 1978). The Oxford history is marred by its Anglocentric bias. A handy compendium of the first five volumes is available in T.K. Derry and T.I. Williams, *A Short History of Technology from the Earliest Times to A.D. 1900* (Oxford: Clarendon Press, 1960). The two-volume collection on *Technology in Western Civilization*, edited by Melvin Kranzberg and Carroll Pursell (New York: Oxford University Press, 1967), is less comprehensive but more instructive. The second volume focuses on twentieth-century American developments.

There are a number of one-volume histories of American technology, but none is entirely satisfactory. J.W. Oliver's *History of American Technology* (New York: Ronald, 1956) is dry and unreliable. Roger Burlingame's *Engines of Democracy: Invention and Society in Mature America* (New York: Scribner's, 1940) and *March of the Iron Men: A Social History of Union Through Invention* (New York: Scribner's, 1938) are still useful. Elting E. Morison's more recent *From Know-How to Nowhere: The Development of American Technology* (New York: Basic Books, 1974) is both entertaining and informative.

III. *Anthologies*: Edwin T. Layton, ed., *Technology and Social Change in America* (New York: Harper & Row, 1973) is a valuable collection of historical articles on the subject. Melvin Kranzberg and William H. Davenport, eds., *Technology and Culture: An Anthology* (New York: New American Library, 1975) contains several important pieces on American technology. Thomas Parke Hughes, ed., *Changing Attitudes Toward American Technology* (New York: Harper & Row, 1975) and Carroll Pursell, Jr., ed., *Readings in Technology and American Life* (New York: Oxford University Press, 1969) are illuminating collections of primary materials.

IV. *Journals*: The core journal in the field is *Technology and Culture*. Articles of interest appear in a wide variety of other periodicals, including *Business History Review, IA: Journal of the Society for Industrial Archeology, Isis*, and the *Journal of Economic History*.

V. *Bibliographies*: The standard bibliography is Eugene S. Ferguson, *Bibliography of the History of Technology* (Cambridge, MA: MIT Press, 1968). Ferguson is not limited to American technology. For the period before 1850, see Brooke Hindle, *Technology in Early America: Needs and Opportunities for Study*, with a Directory of Artifact Collections by Lucius F. Ellsworth (Chapel Hill: University of North Carolina Press, 1966). A recent bibliography that is helpful for the later period, but not limited to history of technology per se, is Stephen H. Cutcliffe, Judith A. Mistichelli and Christine Roysdon, Technology and Values in American Civilization: A Guide to Information Sources (Detroit: Gale Research, 1980). See also Carroll Pursell, "History of Technology," in A Guide to the Culture of Science, Technology, and Medicine, edited by Paul T. Durbin (New York: Free Press, 1980), pp. 70-120; and Thomas Parke Hughes, Jeffrey L. Sturchio, and Edmund N. Todd, "History of Science and Technology," in Murray G. Murphey, ed., American Studies: An Annotated Bibliography of Works on the Civilization of the United States (Washington, D.C.: U.S. Information Agency, 1983).

Current work in the field may be followed in the annual bibliographies in each April issue of Technology and Culture.

LECTURE TOPICS AND READING ASSIGNMENTS

1. Introduction: The Economic and Social Matrix of Early American Technology.

REQUIRED:

Rosenberg, Technology and American Economic Growth, pp. 1-58.

RECOMMENDED:

Brooke Hindle, Emulation and Invention (New York: New York University Press, 1981), Chapter 1, "The Machine in the New Nation," 1-23.

2. American "Know-How," Patterns of Trade, and Improving Entrepreneurs: Contexts for the Transfer of Technology to Early Nineteenth-Century America.

REQUIRED:

Rosenberg, Technology and American Economic Growth, pp. 59-86.

Pursell, ed., Technology in America, pp. 8-16, 34-44 (Chapters on America's Wooden Age and Benjamin Henry Latrobe).

RECOMMENDED:

Chandler, Visible Hand, 15-49.

Eugene S. Ferguson, "On the Origin and Development of American Mechanical 'Know-How'," Midcontinent American Studies Journal 3 (Fall 1962): 3-16. Reprinted in Edwin T. Layton, Jr., Technology and Social Change in America (New York: Harper & Row, 1973), pp. 9-24.

Hindle, Emulation and Invention, pp. 25-83 (on steamboats).

__________, ed., America's Wooden Age: Aspects of Its Early Technology (Tarrytown, NY: Sleepy Hollow Press, 1975).

__________, ed., Material Culture of the Wooden Age (Tarrytown, NY: Sleepy Hollow Press, 1981).

David J. Jeremy, "British Textile Technology Transmission to the United States: The Philadelphia Region Experience, 1770-1820," Business History Review 47 (Spring 1973): 24-52.

__________, Transatlantic Industrial Revolution: The Diffusion of Textile Technologies Between Britain and America, 1790-1830s (Cambridge, MA: MIT Press, 1981).

Norman B. Wilkinson, "Brandywine Borrowings from European Technology," Technology and Culture 4 (Winter 1963): 1-13.

3. *From Farms to Factories: Lowell and the Vision of a Republican Technology*.

REQUIRED:

Kasson, *Civilizing the Machine*, pp. 3-106.

Pursell, ed., *Technology in America*, pp. 17-33 (Jefferson chapter).

RECOMMENDED:

Chandler, *Visible Hand*, pp. 50-78.

David J. Jeremy, "Innovations in American Textile Technology During the Early Nineteenth Century," *Technology and Culture* 14 (January 1973): 40-76.

Charles L. Sanford, "The Intellectual Origins and New-Worldliness of American Industry," *Journal of Economic History* 18 (March 1958): 1-16.

Peter Temin, "Steam and Waterpower in the Early Nineteenth Century," *Journal of Economic History* 26 (March 1966): 187-205.

Anthony F. C. Wallace, *Rockdale: The Growth of an American Village in the Early Industrial Revolution* (New York: Knopf, 1978).

4. *The American System of Manufactures*.

REQUIRED:

Pursell, ed., *Technology in America*, pp. 45-61 (Whitney chapter).

Rosenberg, *Technology and American Economic Growth*, pp. 87-116.

RECOMMENDED:

D. L. Burn, "The Genesis of American Engineering Competition, 1850- 1870," *Economic History* 2 (January 1931): 292-311.

Russell Fries, "British Response to the American System: The Case of the Small Arms Industry After 1850," *Technology and Culture* 16 (July 1975): 377-403.

Otto Mayr and Robert C. Post, eds., *Yankee Enterprise: The Rise of the American System of Manufactures* (Washington, D.C.: Smithsonian Institution Press, 1982).

Nathan Rosenberg, "Technological Change in the Machine Tool Industry, 1840-1910," *Journal of Economic History* 23 (December 1963): 414-43.

__________, ed., *The American System of Manufacturs* (Edinburgh: Edinburgh University Press, 1969).

S. B. Saul, ed., *Technological Change: The United States and Great Britain in the Nineteenth Century* (London: Methuen, 1970).

John E. Sawyer, "The Social Basis of the American System of Manufacturing," *Journal of Economic History* 14 (December 1954): 361-79.

Bruce Sinclair, "At the Turn of a Screw: William Sellers, the Franklin Institute, and a Standard American Thread," *Technology and Culture* 10 (January 1969): 20-34.

Merritt Roe Smith, "John H. Hall, Simeon North, and the Milling Machine: The Nature of Innovation Among Antebellum Arms Makers," *Technology and Culture* 14 (October 1973): 573-91.

Paul Uselding, "Elisha K. Root, Forging, and the 'American System'," *Technology and Culture* 15 (October 1974): 543-68.

Robert S. Woodbury, "The Legend of Eli Whitney and Interchangeable Parts," *Technology and Culture* 1 (Summer 1960): 235-53.

5. *Iron and Steel and Industrialization*.

REQUIRED:

Alfred D. Chandler, "Anthracite Coal and the Beginnings of the Industrial Revolution in the United States," *Business History Review* 46 (Summer 1972): 141-81.

RECOMMENDED:

W. David Lewis, *Iron and Steel in America* (Wilmington, DE: Hagley Museum, 1976).

Elting E. Morison, "John Fritz and the Three High Rail Mill," in *From Know-How to Nowhere: The Development of American Technology* (New York: Basic Books, 1974), pp. 72-86.

__________, "'Almost the Greatest Invention'," in *Men, Machines, and Modern Times* (Cambridge, MA: MIT Press, 1966), pp. 123-205.

Peter Temin, *Iron and Steel in Nineteenth-Century America* (Cambridge, MA: MIT Press, 1964).

6.,7. *Managing an Expanding Transportation System: The Railroads and the Telegraph*.

REQUIRED:

Chandler, *Visible Hand*, pp. 79-205.

RECOMMENDED:

Richard B. DuBoff, "Business Demand and the Development of the Telegraph in the United States, 1844-1860," *Business History Review* 54 (Winter 1980): 459-79.

Hindle, *Emulation and Invention*, 85-125 (on the telegraph).

John F. Stover, *American Railroads* (Chicago: University of Chicago Press, 1961), chapters 1-3.

Robert L. Thompson, *Wiring a Continent: The History of the Telegraph Industry in the United States,1832-1866* (Princeton: Princeton University Press, 1947). Reprint ed. (New York: Arno Press, 1972).

8. *The "Machine in the Garden": Cultural Responses to Nineteenth-Century Technology*.

REQUIRED:

Kasson, *Civilizing the Machine*, pp. 109-80.

Leo Marx, "The Machine in the Garden," *New England Quarterly* 29 (March 1956): 27-41. Reprinted in Layton, ed., *Technology and Social Change in America*, pp. 121-30.

Hugo A. Meier, "American Technology and the Nineteenth-Century World," *American Quarterly*, 10 (Summer 1958): 116-30.

__________, "Technology and Democracy, 1800-1860," *Mississippi Valley Historical Review* 43 (March 1957): 618-40. Reprinted in Layton, ed., *Technology and Social Change in America*, pp. 79-97.

9. *The Corporate Revolution: Technology, Markets, and Management*.

REQUIRED:

Chandler, *Visible Hand*, pp. 240-314.

Noble, *America By Design*, pp. 3-19.

RECOMMENDED:

Chandler, *Visible Hand*, pp. 206-39, 315-79.

Chandler, "The Beginnings of 'Big Business' in American Industry," *Business History Review* 33 (Spring 1959): 1-31.

10. *Inventors, Engineers, and Entrepreneurs: Emergence of Professional Cultures*.

REQUIRED:

Pursell, ed., *Technology in America*, pp. 71-116 (Chapters on McCormick, Eads, Francis, and Bell).

RECOMMENDED:

David A. Hounshell, "Bell and Gray: Contrasts in Style, Politics, and Etiquette," *Proceedings of the IEEE* 64 (September 1976): 1305-14.

__________, "Edison and the Pure Science Ideal in Nineteenth-Century America," *Science* 207 (8 February 1980): 612-17.

__________, "Elisha Gray and the Telephone: On the Disadvantages of Being an Expert," *Technology and Culture* 16 (April 1975): 133-61.

__________, "Two Paths to the Telephone," *Scientific American* 244 (January 1981): 157-63.

Thomas Parke Hughes, "Edison's Method," in *Technology at the Turning Point*, ed. by William B. Pickett (San Francisco: San Francisco Press: 1977), pp. 5-22.

__________, *Elmer Sperry: Inventor and Engineer* (Baltimore, MD: Johns Hopkins University Press, 1971), pp. 63-70.

__________, "Inventors: The Problems They Choose, the Ideas They Have, and the Inventions They Make," in Patrick Kelly and Melvin Kranzberg, eds., *Technological Innovation* (San Francisco: San Francisco Press, 1978), pp. 166-82.

__________, *Thomas Edison: Professional Inventor* (London: Her Majesty's Stationery Office, 1976).

Reese V. Jenkins, "Technology and the Market: George Eastman and the Origins of Mass Amateur Photography," *Technology and Culture* 16 (January 1975): 1-19.

Edwin T. Layton, Jr., "Mirror-Image Twins: The Communities of Science and Technology in Nineteenth-Century America," *Technology and Culture* 12 (October 1971): 562-80.

A. Michal McMahon, "Corporate Technology: The Social Origins of the American Institute of Electrical Engineers," *Proceedings of the IEEE* 64 (September 1976): 1383-90.

11. *The Industrialization of Invention*.

REQUIRED:

Noble, *America By Design*, pp. 69-131.

Pursell, ed., *Technology in America*, pp. 129-41 (Eastman chapter).

RECOMMENDED:

Noble, *America By Design*, pp. 131-66.

James E. Brittain, "C. P. Steinmetz and E. F. W. Alexanderson: Creative Engineering in a Corporate Setting," *Proceedings of the IEEE* 64 (September 1976): 1413-17.

__________, "The Introduction of the Loading Coil: G. A. Campbell and M. I. Pupin," *Technology and Culture* 11 (January 1970): 36-57.

Lillian Hoddeson, "The Emergence of Basic Research in the Bell Telephone System, 1875-1915," *Technology and Culture* 22 (July 1981): 512-44.

Thomas Parke Hughes, "The Science-Technology Interaction: The Case of High-Voltage Power Transmission Systems," *Technology and Culture* 17 (October 1976): 649-59.

Edwin T. Layton, Jr., "Scientific Technology, 1845-1900: The Hydraulic Turbine and the Origins of American Industrial Research," *Technology and Culture* 20 (January 1979): 64-89.

Leonard S. Reich, "Industrial Research and the Pursuit of Corporate Security: The Early Years of Bell Labs," *Business History Review* 54 (Winter 1980): 504-29.

__________, "Research, Patents, and the Struggle to Control Radio: A Study of Big Business and the Uses of Industrial Research," *Business History Review* 51 (Summer 1977): 208-35.

George Wise, "A New Role for Professional Scientists in Industry: Industrial Research at General Electric, 1900-1916," *Technology and Culture* 21 (July 1980): 408-29.

12. *The Electrification of America*

REQUIRED:

Pursell, ed., *Technology in America*, pp. 117-28, 202-12 (Chapters on Edison and Cooke).

Chandler, *Visible Hand*, pp. 426-33.

Thomas Parke Hughes, "The Electrification of America: The System- Builders," *Technology and Culture* 20 (January 1979): 124-61.

RECOMMENDED:

Robert B. Belfield, "The Niagara System: The Evolution of an Electrical Power Complex at Niagara Falls, 1883-1896," *Proceedings of the IEEE* 64 (September 1976): 1344-50.

Robert Conot, *A Streak of Luck* (New York: Bantam Books, 1980).

Richard B. DuBoff, "The Introduction of Electric Power in American Manufacturing," *Economic History Review* 20 (December 1967): 509-18.

Matthew Josephson, *Edison: A Biography* (New York: McGraw-Hill, 1959).

Harold C. Passer, *The Electrical Manufacturers, 1875-1900: A Study in Competition, Entrepreneurship, Technical Change, and Economic Growth* (Cambridge, MA: Harvard University Press, 1953). Reprint ed. (New York: Arno Press, 1972).

Terry S. Reynolds and T. Bernstein, "The Damnable Alternating Current," *Proceedings of the IEEE* 64 (September 1976): 1339-43.

13. *Automobiles, Mass Production, and American Consumer Culture*.

REQUIRED:

Pursell, ed., *Technology in America*, pp. 163-75 (Ford chapter).

R. S. and H. M. Lynd, *Middletown: A Study in Modern American Culture* (New York: Harcourt, Brace, 1929), pp. 153-78, 251-71.

Ruth Schwartz Cowan, "The 'Industrial Revolution' in the Home: Household Technology in the Twentieth Century," *Technology and Culture* 17 (January 1976): 1-23.

RECOMMENDED:

Rosenberg, Technology and American Economic Growth, pp. 117-72.

Daniel Boorstin, The Americans: The Democratic Experience (New York: Random House, 1973).

James J. Flink, "Three Stages of American Automobile Consciousness," American Quarterly 24 (October 1972): 451-73.

William E. Leuchtenberg, The Perils of Prosperity, 1914-1932 (Chicago: University of Chicago Press, 1958), Chapter X: "The Second Industrial Revolution," pp. 178-203.

David L. Lewis, ed., The Automobile and American Culture, Special Issue of the Michigan Quarterly Review (Ann Arbor: Michigan Quarterly Review, 1980).

14.,15. Engineers, Scientific Management, and Corporate Hierarchies.

REQUIRED:

Noble, America By Design, pp. 167-206, 234-324.

RECOMMENDED:

Chandler, Visible Hand, pp. 381-500.

Edwin T. Layton, Jr., "Science, Business, and the Engineer," in Robert Perrucci and Joel E. Gerstl, eds. The Engineer and the Social System (New York: Wiley, 1969), pp. 51-72.

__________, "Veblen and the Engineers," American Quarterly, 14 (Spring 1962): 62-72. Reprinted in Layton, ed., Technology and Social Change in America, pp. 147-55.

Stuart W. Leslie, "Charles F. Kettering and the Copper-Cooled Engine," Technology and Culture 20 (October 1979): 752-76.

__________, "Thomas Midgley and the Politics of Industrial Research," Business History Review 54 (Winter 1980): 480-503.

Seymour Melman, "Alternative Criteria for the Design of Means of Production," Theory and Society 10 (May 1981): 325-36.

Daniel Nelson, "Scientific Management, Systematic Management, and Labor, 1880-1915," Business History Review 48 (Winter 1974): 479-500.

David F. Noble, "Social Choice in Machine Design: The Case of Automatically Controlled Machine Tools," in Andrew Zimbalist, ed., Case Studies on the Labor Process (New York: Monthly Review Press, 1979), pp. 18-50. A different version of this essay appears in Politics and Society 8 (May 1978): 313-47.

Frederick W. Taylor, The Principles of Scientific Management 1911. Reprint ed. (New York: Norton, 1967).

16. Review

RECOMMENDED:

Rosenberg, Technology and American Economic Growth, pp. 172-201.

Eugene S. Ferguson, "The American-ness of American Technology," Technology and Culture 20 (January 1979): 3-24.

Nathan Rosenberg, "Technological Interdependence in the American Economy," Technology and Culture 20 (January 1979): 25-50.

CIVILIZING THE MACHINE: HISTORY OF AMERICAN TECHNOLOGY

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Introduction

In 1933 Lucy M. Salmon included a short essay entitled "History in a Backyard" in her book, Historical Material (NY: Oxford University Press, 1933). Wherever one glances, she suggested, objects provide a ready lesson in the historical mode of analysis, for all things have developed over time, all things are somehow related to people living and gone. One need not search far to begin understanding the path from past to present. Ready made lessons surround the would-be student, the teacher and scholar.

Most students of history are educated in a traditional way, from survey course to colloquium to seminar, largely eschewing local history as a mere "welter of minor excitements." Ms. Salmon's teaching suggests there are alternative pedagogical approaches, and Gavilan College's "Civilizing the Machine: History of American Technology" attempts to raise local history to the service of the instructor and student.

As the outline suggests, this course skims through major aspects of the history of American technology from Thomas Digges and the transfer of technology, the heroic age of invention in the nineteenth century, the birth of the General Electric and other research laboratories, to the complex interrelationship of technology and society in modern American life. Close attention is paid to the realm of techniques and human values, to conflicts and romances, to chicken and egg questions. Students are asked in conclusion to analyze the relationship of technology and values and to determine for themselves whether or not technology has its own imperative or is indeed a product and agent of humankind. Such is the general framework within which the real core of the course exists.

The essence of "Civilizing the Machine" rests in individual student research projects to which 30 to 40 percent of classroom discussion is devoted. Local industrial, agricultural, and public works sites are discussed, and students select a site for research. Techniques of research are presented, from the rudiments of note-taking to the art of observation. Source materials for local research are introduced, including "mug-book" histories, local government archives, court records, newspaper collections, oral history interviews, photographic records, insurance and other maps, and the stores of information available in private enterprise and personal collections. Published materials which might relate local sites to larger state and national frameworks are suggested, and the art of using a local topic as a window to a much broader subject is explored. Students then go forth and comb archival and library resources, conduct interviews, gather newspaper and other material, physically inspect their sites, and take photographs. Weekly project reports are an integral part of the process, and students are encouraged to cooperate in their research efforts, sharing information, sources, and ideas. By the last week of the quarter projects are ready for presentation to the class, using whatever photographic and other visual and artifactual aids are feasible for the reseacher.

As the reading and lecture portion of the course touches upon topics close to the student research projects, the research takes on new importance and excitement. Inspiration for a study of a nineteenth century redwood sawmill site comes from discussions about technologies of America's wooden age and Eric Sloane's A Reverence for Wood, 1965. Reprint ed. (N.Y.: Balantine, 1973). The American System of Manufactures gives added meaning to a study of an early flour mill, and a brewery study offers suggestive thoughts concerning the transfer of technology from Europe to America. The linkage of science and technology and the rise of engineering in the late-nineteenth century come to life in a student's investigation of a local community water system's development, and the history of a farm opens the door to discussion of technology in agriculture.

Since we live in a time when communities and organizations across the nation are showing increased interest in knowing and preserving their material and cultural heritage, when sites of historic importance can occasionally stand safe before the bulldozer, students' local research projects can have significance beyond development of research and writing skills. Local histories provide an exciting and effective teaching technique. Students get first hand research and analysis experience, they gain an insight into seeing both society and the things of society as they have developed over time, and history seems to take on a new importance. This importance is emphasized when students are encouraged to see their work as having importance beyond a grade in a college course. The are encouraged to place copies of their work in the college library and the files of the community history museum, and several students have had their papers published in a single volume by the local historical society.

Syllabus

The American romance with technology has been paradoxical and fraught with conflict. This course investigates the use and abuse of machines through America's history, emphasizing the interrelationship of values and technology. An investigative project in American material culture or the history of American technology is an integral part of this course.

General Course Objectives:

At the conclusion of this course, the student should be able to:

1. show knowledge and understanding of basic facts and concepts concerning the nature and development of American technology.
2. identify and explain the roots of the American exerience with technology and its relationship with our value system.
3. evaluate concepts such as those of authoritarian and democratic technology and the interrelationship of the environment and technology.
4. identify specific events, individuals, theories, and terminology significant to the history of technology.
5. carry out a well-defined historical research project.

Texts and reading include:

Edwin T. Layton, Jr., ed. Technology and Social Change In America (NY: Harper & Row, 1973).
Eric Sloane, A Reverance For Wood. 1965. Reprint ed. (NY: Ballantine 1973).
Mark Twain, A Connecticut Yankee in King Arthur's Court 1889. Reprint ed. (NY: Harper & Brothers, 1960).
Lynn White, Jr., "The Historical Roots of Our Ecological Crisis" and "Continuing the Conversation," in Western Man and Environmental Ethics, edited by Ian G. Barbour (Menlo Park, California: Addison-Wesley, 1973), pp. 18-30 and 55-64.
James J. Flink, "Three Stages of American Automobile Consciousness," American Quarterly 24 (October 1972): 451-73.
Lewis Mumford, "Authoritarian and Democratic Techniques," Technology and Culture 5 (January 1964): 1-8.
James C. Williams, "The Trolley: Technology and Values in Retrospect," San Jose Studies 3 (November 1977): 74-90.
Kurt Vonnegut, Player Piano 1952. Reprint ed. (NY: Delacorte Press, 1977). Recommended reading.

Course requirements and grading:

Grading will be based upon letter grades assigned two exams and a research paper. The midterm exam is a take-home assignment, and the final exam will be completed during the scheduled examination period.

The research project is an integral part of the course, amounting to 40% of the course grade. You will undertake identification, location, and thorough investigation of a local material culture site or undertake another topic in technological history. You can work alone or with another student, depending upon the project chosen. We will spend substantial class time on these projects -- weekly progress will be reported.

Course outline:

During the first 2-1/2 weeks we shall discuss the relationship of technology and humankind, seeking proper definitions and a basis for further conversation. Then we shall turn to the roots of American technology, discussing the colonies and the impact on America of English technology during the Industrial Revolution, its importation and adaptation. Your reading should start immediately with the White articles; Mumford, "Authoritarian and Democratic Technics;" Layton, "Introduction;" Sloane's book; and Layton, pp. 9-24.

We will turn then to the early development of American technology, discussing the American system of manufactures and the heroic age of invention during the 19th century. Your reading includes Layton, pp. 47-78, 25-46, and 79-97, in that order, and the Twain book. This should bring us to May 1st and your midterm paper. I will also want a written report on your projects at this point.

The next section of our venture will look at science and technology and the rise of engineering during the 19th century, how scientific technology interrelated with the people of America, and the rise of the modern corporation and its role in technology. Your reading includes Layton, pp.

131-46; Flink, "Three Stages of Automobile Consciousness;" Layton, pp. 147-56; Williams, "The Trolley;" and the recommended book by Vonnegut.

We will turn then to the interrelationships of technology and corporations and technology and government in the 20th century, concluding with discussion about the meaning of technology in this century. You should read Layton, pp. 99-120, 121-30, 157-73, and Vonnegut, which is again recommended. This material will be covered on your final examination. You will also give a final project report in class and turn in your projects on June 11th.

Sample Examinations

Midterm examination. This is a take-home exam, due in one week. Type your essay, double-spacing. Be sure to proofread, checking for spelling, grammar, and proper sentence construction. You will need to complete a minimum of four or five pages in order to properly deal with the topic.

Lewis Mumford has written that there are two types of technology, one authoritarian ("system-centered, immensely powerful, but inherently unstable") and one democratic ("man-centered, relatively weak, but resourceful and durable"). Mumford believes that at the very time the new American nation was casting off authoritarian politics in its revolution against Great Britain, it was adopting an authoritarian technology in place of the old political system.

Further defining Mumford's terms, discuss his ideas in terms of the development of American technology from the earliest times to the late-nineteenth century. Be as specific in giving examples and evidence as you can.

Final examination. This is a two-hour examination.

During the past few weeks you've read several articles dealing with technology and society. John Burke looks at the relationship of technology and government, suggesting technology has had an important role in governmental activity in society. Leo Marx suggests that technology in our society has been important in separating our heads and hearts, rationality and aesthetics. Herbert Muller sees, similarly, that our overriding interest in means (money) obscures the end we seek (holistic happiness) and that our whole society is to blame. With Carl Condit's article we see the merging of science and technology into a powerful force in society, and in Ed Layton's article we see the rise of an important technological ideology in our society. Finally, James Flink offers us a study of automobility in America which suggests a model of technological adoption, acceptance, and changing interrelationship with society.

A common complaint of some members of society is that we live in a world dominated by a "technological fix" mentality. For our individual headaches we take aspirin; for our social headaches we take another dose of technology. Discuss the articles you've read and technology in American society since the late 19th Century in light of the view that the "technological fix" is dominant in America. In your conclusion try to shed some light on what one might do, if this attitude is correct.

Sample Research Topics

J.G. McMillan, civil engineer and bridge builder in Santa Clara County at turn of the century. A short biography.

Gilroy Water System. The system and engineers, surveyors, and contractors who worked on the system between 1871 and 1900. Developments in the system after 1900.

Development of the tobacco industry in South Valley in the late 19th Century -- techniques developed by J.D. Culp.

Impact of farming technology on the environment of South Valley in either the 19th or 20th centuries.

Oil exploration and production in South Valley from the 1880s to the present:

a. In depth oral history with Albert Carrey, oilman now retired in Gilroy.

b. Focused examination of oil development during a particular decade; e.g., the 1880s or the 1920s.

Miscellaneous topics might include public works history, specific agricultural development, the food processing industry, energy on the farm, the seed industry, impact of the automobile locally, development of the railroad, etc.

AMERICAN SCIENCE AND TECHNOLOGY

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American Science and Technology, HSST 342/542, is a reading course for upper-level undergraduates and graduate students. Since most of those who enroll have little or no background in the history of science and technology, my intent has been to develop what I feel are central themes as well as to introduce them to stimulating scholarship. The course regularly draws graduate students in Museum Studies, and a special effort is made in class sessions to relate the readings to curatorial concerns.

Each week all of the students read certain articles or excerpts, and one or two students provide the class with a written critical book review selected from the week's list.

The purposes of the course are:

1. to follow the historical development of science and technology in the U.S.;
2. to consider the main issues in that development;
3. to become acquainted with the major works in the field.

TOPICS AND READINGS

Week

1. Introduction

   I. Bernard Cohen, *Benjamin Franklin: Scientist and Statesman* (New York: Scribner's, 1975).

2. General Works on the History of American Science

   "Introduction," in David D. Van Tassel and Michael G. Hall, eds., *Science and Society in the U.S.* (Homewood, IL: Dorsey Press, 1966).
   Review:
   Nathan Reingold, ed., *Science in Nineteenth Century America: A Documentary History* 1964. Reprint ed. (New York: Octagon Books, 1979).
   Dirk J. Struik, *Yankee Science in the Making* Rev. ed. (New York: Collier Books, 1962).
   Van Tassel and Hall, eds., *Science and Society in the U.S.*

3. General Works on the History of American Technology

   Brooke Hindle, "The Exhilaration of Early American Technology," *Technology in Early America: Needs and Opportunities for Study* (Chapel Hill, NC: University of North Carolina Press, 1966), pp. 3-28.
   Review:
   Elting E. Morison, *From Know-How to Nowhere* (New York: Mentor Books, 1977).
   Carroll W. Pursell, Jr., ed., *Technology in America: Individuals and Ideas* (Cambridge, MA: MIT Press, 1981).

Roger Burlingame, *March of the Iron Men* (New York: Scribner, 1938).

Roger Burlingame, *Engines of Democracy* (New York: Scribner, 1940).

Nathan Rosenberg, *Technology and American Economic Growth* (New York: Harper & Row, 1972). Reprint ed. (White Plains, NY: M. E. Sharpe, 1976).

4. Colonial Science

Frederick C. Tolles, "Philadelphia's First Scientist, James Logan," *Isis* 47 (March 1956): 2-30.

George F. Frick, "The Royal Society in America," in Alexandra Oleson and Sanborn C. Brown, eds., *The Pursuit of Knowledge in the Early American Republic* (Baltimore: Johns Hopkins University Press, 1976), pp. 70-83.

John C. Burnham, *Science in America* (New York: Holt, Rinehart, Winston, 1971), pp. 12-18.

Review:

Brooke Hindle, *The Pursuit of Science in Revolutionary America* (Chapel Hill, NC: University of North Carolina Press, 1956).

5. Colonial Technology

Carl W. Condit, *American Building* (Chicago: University of Chicago Press, 1968), pp. 2-25.

Carroll W. Pursell, Jr., ed., *Readings in Technology and American Life* (New York: Oxford University Press, 1969), pp. 7-9, 18-26.

Review:

Arthur Bining, *Pennsylvania Iron Manufacture in the Eighteenth Century* (Harrisburg, PA: Pennsylvania Historical Commission, 1938).

Carl Bridenbaugh, *The Colonial Craftsman* (Chicago: University of Chicago Press, 1961).

6. The Americanization of Science and Technology

Eugene S. Ferguson, "Technology as Knowledge," in Edwin T. Layton, ed., *Technology and Social Change in America* (New York: Harper & Row, 1973), pp. 9-24.

Hugo Meier, "The Ideology of Technology," in *Ibid*, pp. 79-97.

John C. Greene, "American Science Comes of Age," *Journal of American History* 55 (June 1968): 22-41.

Review:

Eugene S. Ferguson, ed., *Early Engineering Reminiscences (1815-1840) of George Escol Sellers* (Washington: Smithsonian Institution, 1965).

Brooke Hindle, *Emulation and Innovation* (New York: New York University Press, 1981).

David J. Jeremy, *Transatlantic Industrial Revolution: The Diffusion of Textile Technologies Between Britain and America, 1790-1830s* (Cambridge, MA: MIT Press, 1981).

7. Institutionalization and Professionalization

George Daniels, "The Process of Professionalization in American Science," *Isis* 58 (Summer 1967): 151-66.

John C. Greene, "Science, Learning, and Utility," in Oleson and Brown, eds., *The Pursuit of Knowledge*, pp. 1-20.

Patsy Gerstner, "The Academy of Natural Sciences in Philadelphia, 1812-1850," in Ibid., pp. 175-93.
Review:
Bruce Sinclair, Philadelphia's Philosopher Mechanics: A History of the Franklin Institute, 1824-1865 (Baltimore: Johns Hopkins University Press, 1974).
George Daniels, American Science in the Age of Jackson (New York: Columbia University Press, 1968).

8. Industrialization and Community

Merritt Roe Smith, Harpers Ferry Armory and the New Technology: The Challenge of Change (Ithaca, NY: Cornell University Press, 1977).

9. Industrialization and Labor

John Kasson, Civilizing the Machine: Technology and Republican Values in America, 1776-1900 (New York: Grossman, 1976), ch. 2.
Kenneth M. Stampp, The Peculiar Institution (New York: Vintage Books, 1956), ch. 2.
Review:
Thomas Dublin, Women at Work: The Transformation of Work and Community in Lowell, Massachusetts (New York: Columbia University Press, 1979).
Norman Ware, The Industrial Worker, 1840-1860: The Reaction of American Industrial Society to the Advance of the Industrial Revolution 1924. Reprint ed. (Chicago: Quadrangle Books, 1964).
Robert Starobin, Industrial Slavery in the Old South (New York: Oxford University Press, 1970).

10. Science, Technology and Government in the 19th Century

Eugene S. Ferguson, "Exhibitions of Technology, 1851-1900," in Melvin Kranzberg and Carroll W. Pursell, Jr., eds., Technology in Western Civilization 2 vols. (New York: Oxford University Press, 1967), 1: 706-25.
Walter B. Hendrickson, "Nineteenth-Century State Geological Surveys," Isis 52 (September 1961): 357-71.
John Burke, "Technology in Government," in Layton, ed., Technology and Social Change in America, pp. 99-119.
Review:
A. Hunter Dupree, Science in the Federal Government (Cambridge, MA: Harvard Universty Press, 1957).
Otto Mayr and Robert C. Post, eds., Yankee Enterprise: The Rise of the American System of Manufactures (Washington: Smithsonian Institution Press, 1981).

11. The Rise of Modern Scientific and Technical Institutions

Edwin T. Layton, "The Communities of Science and Technology in 19th Century America," Technology and Cultue 12 (October 1971): 562-80.
Charles Weiner, "Science and Higher Education," in Van Tassel and Hall, eds., Science and Society in the U.S., pp. 163-89.

Review:
Clarence Cramer, Case Institute of Technology (Cleveland: Case Western Reserve Univerity, 1980).
Bruce Sinclair, A Centennial History of the American Society of Mechanical Engineers, 1880-1980 (Toronto: University of Toronto Press, 1980).
Thomas G. Manning, Government in Science: The U.S. Geological Survey, 1867-1894 (Lexington, KY: University of Kentucky Press, 1967).
Reese Jenkins, Images and Enterprise: Technology and the American Photographic Industry, 1839-1925 (Baltimore: Johns Hopkins University Press, 1975).

12. Some Great Men and Women

David Hounshell, "Bell and Gray: Contrasts in Style, Politics, and Etiquette," IEEE Proceedings 64 (September 1976): 1305-14.
David Hounshell, "Edison and the Pure Science Ideal in 19th Century America," Science 207 (8 February 1980): 612-17.
Ruth S. Cowan, "Ellen Swallow Richards: Technology and Women," in Pursell, ed., Technology in America, pp. 142-50.
Review:
Matthew Josephson, Edison (New York: McGraw-Hill, 1959).
Thomas P. Hughes, Elmer Sperry, Inventor and Engineer (Baltimore: Johns Hopkins University Press, 1971).
Edward Lurie, Louis Agassiz (Chicago: University of Chicago Press, 1960).
A. Hunter Dupree, Asa Gray (Cambridge, MA: Belknap Press, 1959).
Robert C. Post, Physics, Patents & Politics: A Biography of Charles Grafton Page (New York: Science History Publications, 1976).

13. The Automobile

James J. Flink, "Three Stages of Automobile Conciousness," American Quarterly 24 (October 1972): 451-73.
John Rae, "The Rationalization of Production," in Kranzberg and Pursell, eds., Technology in Western Civilization 2: 37-52.
Review:
James J. Flink, The Car Culture (Cambridge, MA: MIT Press, 1975).
John Rae, The Road and Car in American Life (Cambridge, MA: MIT Press, 1971).

14. Science, Technology and American Culture

Leo Marx, "Alienation and Technology," in Layton, ed., Technology and Social Change in America, pp. 121-30.
Charles Rosenberg, No Other Gods: On Science and American Social Thought (Baltimore: Johns Hopkins University Press, 1976), ch. 7.
Review:
John Kouwenhoven, Made in America: The Arts in Modern American Civilization 1948 Reprint ed. (New York: W. W. Norton, 1967).

Alan Trachtenberg, Brooklyn Bridge: Fact and Symbol 2nd ed. (Chicago: University of Chicago Press, 1979).

15. Engineers in Modern Society

Tracy Kidder, The Soul of a New Machine (New York: Avon, 1982).

16. Scientists in Modern Society

Nicholas Wade, "Guillemin and Schally," Science 200 (21 April 1978): 279-82, (28 April 1978): 411-15, (5 May 1978): 510-13.
Robert L. Sinsheimer, "The Presumptions of Science," in Gerald Holton and Robert S. Morison, eds., The Limits of Scientific Inquiry (New York: W. W. Norton, 1979), pp. 23-35.
David Baltimore, "Limiting Science: A Biologist's Perspective," in Ibid., pp. 37-45.
Review:
James Watson, The Double Helix (New York: Athenaeum, 1968).

Exam Week: Essay Final Examination

AMERICA'S TECHNOLOGICAL STYLE: 1790 to 1980

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COURSE GOAL:

In this course we will study the American technological experience. The specific approach taken is summarized in the following questions. If you are able, at the end of the course, to respond to these questions (with intelligent positions based on historical evidence) you have successfully handled the course.

1. When did a recognizable American style of technology emerge ?
2. How do specific technological systems reveal the tension between design-constraints and the cultural values, motives, and world views of their designers?
3. How has that style evolved since its emergence, and what factors have influenced its evolution?
4. How does the momentum of a system -- once it becomes a part of our style -- influence American life and later American technological decisions?
5. Who gains and who loses because of the design of a system?
6. Is the American style transferrable across cultural lines?
7. Is the American style in crisis today?

A NOTE ON THE WORD "STYLE":

The word "style" is purposely elusive. At no time in the course will you be given a definition of America's style of technology. You will be encouraged, in as many ways as I can think of, to integrate two dimensions of knowledge which cannot be separated for good historical understanding. The two are:

1. Specific Data (about a given technology: dates, people, events, design characteristics, etc.)

2. Interpretations of that data (what does it mean?)

Neither the historical data nor the interpretations can be left out. On the one hand, to spin out interpretations (about the meaning of some technology) without thinking about real evidence is just arm-chair theorizing. On the other hand, to simply list historical particulars without the hard labor of interpreting what they mean is to drive history into boredom, making it a list of "one damn thing after another."

Finally, it is your own interpretation of America's changing technological style that matters to you. You will hear many of my own interpretations, and you will read those of other historians, but these are meant as helps and not as substitutes for your own thinking. After all, if our culture continues to survive, most of you have about twenty years more time to live with our technological style than I probably will.

A NOTE ON HISTORICAL THINKING

You might find it helpful to contrast the kind of learning needed in history with the kind required when learning a language or a mathematical system. A language is a completed system that confronts you, the learner, as a whole. The data and interpretations are fixed in advance. To learn it you must submit yourself to that fixed system.

Here, the interpretations of historical evidence are not fixed. There are some intelligent interpretations already articulated by historians, but the work of interpretation is never finished. As a result, a better model for the kind of learning here is adult interaction with the evidence rather than submission to the fixed system. Historical learning is acquired intimacy. You get better at it the longer you work at trying to interpret evidence. For that reason a high value will be placed on your participation in class discussions. When you think you've spotted a flaw in my --or some other historian's-- interpretation of the evidence as you see it, risk the argument. Whether you change your mind in the process or I change mine, we all learn by the attempt.

REQUIREMENTS AND GRADING:

1. Weekly Quiz: (30% of final grade) Three questions on the week's readings. Focus is on data rather than interpretation. Ten percent off for each mistake.

2. Mid-term Exam: A take-home essay (one week to do it) covering weeks one through seven. Primary focus is on interpretation. (30% of final grade)

3. Final Exam: Standard written exam during finals week. Covers the entire course with a focus on interpretation. (30% of grade)

4. Class Participation: (10% of final grade)

For Graduate Students (HIS 470) Only:

Weekly quiz	15% of grade
Final	25%
Class response	10%
Term paper	25%

Note: I follow the 7 point grading system.
A = 93 - 100
B = 85 - 92
C = 78 - 84
D = 70 - 77

READINGS: (One book, several reserve readings, one packet)

Book: John Kasson, *Civilizing the Machine: Technology & Republican Values in America, 1776-1900* (NY: Penguin, 1976).

Library Reserve: (See notes in Course Calendar below)

THE PACKET:

1. Lecture Notes (titled "Notes" in the Course Calendar)

Introductory concepts	1 - 6
Early American Network of Systems	7
Textiles	8 - 11
Canals	12 - 14
Turnpikes	15
American Machine Tools	16 - 17
"Transfer" "Standardization" "Momentum"	18 - 19
Iron and Steel	20
Railroads	21 - 24
Electric Light and Power	25 - 30
Corporations, R&D, Engineers	31 - 34
Computers	35 - 36
Manhattan Project (Atomic Bomb)	37 - 48

2. John M. Staudenmaier, "Hidden Assumptions in Technology Talk." *New Catholic World* 224 (May-June 1981): 104-107.
3. Norman B. Wilkinson, "Brandywine Borrowings from European Technology," *Technology and Culture* 4 (Jan., 1963) 1-113.
4. John G. Burke, "Bursting Boilers and the Federal Power," *Technology and Culture* 7 (Jan., 1966): 1-23.
5. Merritt Roe Smith, "Military Enterprise & Innovative Process," in Otto Mayr and Robert C. Post, eds. *Yankee Enterprise: The Rise of the American System of Manufacture* (Washington, D.C.: Smithsonian Inst. Pr., 1981): 63-112.
6. H. D. Thoreau, "Paradise to be Regained," in Thomas P. Hughes, ed., *Changing Attitudes Toward American Technology* (NY: Harper & Row, 1975), pp. 87-111.
7. J. Lauritz Larson, "A Systems Approach to the History of Technology: An American Railroad Example." Unpublished manuscript read at the October 1980 SHOT Annual Meeting.
8. Herbert G. Gutman, "Work Culture and Society in Industrializing America, 1815-1919," *American Historical Review* 78 (June 1973): 531-88. Also in his book of the same title (NY: Random House (Vintage) 1977).
9. Thomas P. Hughes, "The Electrification of America: The System Builders," *Technology and Culture* 20 (Jan., 1979): 124-61.
10. Alfred E. Chandler, "The Coming of Big Business," in C. Vann Woodward, ed., *The Comparative Approach to American History* (NY: Basic Books 1968), pp. 220-37.
11. John M. Staudenmaier and C. Stein, "Notes on the Automobile," unpublished manuscript.
12. L. Lowenthal, "Triumph of Mass Idols," in *Literature, Popular Culture and Society* (Palo Alto, CA: Pacific Books, 1968), pp. 109-40.
13. John G. Burke, "Wood Pulp, Water Pollution, and Advertising," *Technology and Culture* 20 (Jan., 1979): 175-95.
14. Thomas M. Smith, "Project Whirlwind: An Unorthodox Development Project," *Technology and Culture* 17 (July 1976): 447-64.
15. Richard G. Hewlett, "Beginnings of Development in Nuclear Technology," *Technology and Culture* 17 (July 1976): 465-78.
16. John M. Staudenmaier, "The Green Revolution," unpublished manuscript.

TERM PAPER: (10-20 pp. graduate students only, typed except by arrangement) Term paper topic must be approved by Week Five; paper is due in Week Eleven.

FOCUS: "THE 'IMAGE' OF A TECHNOLOGY IN THE MEDIA"

Select a type of technology from 1890 to 1950 and interpret its media image in one of two ways.

A) Article Approach: Select 10 to 15 articles about your technology (the *Readers' Guide to Periodical Literature* is a good starting point) and analyze their language, pictures, headlines, etc. to see how that technology was packaged in the various articles.

B) Advertisement Approach: Select 20 to 40 advertisements and analyze their packaging of the technology.

SOME NOTES ON THE PAPER:

1. Begin with an introduction that discusses the following: a) the technology you are treating, b) why you chose the sources you did, c) the limitations of your evidence.

2. Articles and advertisements differ according to journals (e.g. business, news, science, women's, etc.). You may want to sample items from several journal types and contrast or you may stick with one and analyze changes over time. Know what you are doing, though.

3. It is expected that you write formal English, that you proofread carefully for spelling and grammar, and that you use one of the accepted styles of source notation.

4. I expect to spend a good bit of time with each of you as you work on the paper. Be sure to come in regularly.

COURSE CALENDAR:

PART ONE: A DISTINCTLY "AMERICAN" STYLE EMERGES: 1790-1880

INTRODUCTION

WEEK ONE:
Themes:
Emerging Technology: the 3 stage model, Technological.
Momentum, The Middle Landscape.
Readings:
Notes (pp. 1,5,6).
Staudenmaier, "Hidden Assumptions."

WEEK TWO: TEXTILES: AN EARLY AMERICAN SYSTEM
Themes:
Middle landscape vs. American industrialization.
Lowell mills during innovation boom period.
Lowell's different constituencies.
Readings:
Kasson, Ch. 1 "Emergency of Republican Technology."

Kasson, Ch. 2 "Factory as Republican Community."
Notes (7-11).

WEEK THREE: EARLY TRANSPORT SYSTEMS:LAND, WATER, & TECHNOLOGY

Themes:
- Canals (transfer of technology, engineering education).
- Steamboats (influence of terrain, government regulation).
- Roadbuilding (a note on its problems).

Readings:
- Wilkinson, "Brandywine Borrowings."
- Elting E. Morrison, "Building Things in Early America" pp. 15-36 and "Works of John B. Jervis," pp. 37-67, in *From Know-How to Nowhere: The Development of American Technology* (NY: Basic Books, 1974).
- Burke, "Bursting Boilers & Federal Power."
- Notes (12-15)

WEEK FOUR: WORKING METAL: "THE AMERICAN SYSTEM OF MANUFACTURE"

Themes:
- "Standardization" as the new American ideal.
- Military impact on technological style.
- Technology transfer: vehicles and cultural conflicts.

Readings:
- Smith, M.R. "Military Enterprise & Innovative Process."
- Notes (16-19).

WEEK FIVE: FIRST INDUSTRIAL REVOLUTION & REACTIONS TO IT

Themes:
- The industrialization boom after 1840.
- Optimism vs. Pessimism: Thoreau, Etzler, Emerson.

Readings:
- Alfred D. Chandler, Jr., "Anthracite Coal and the Beginnings of the Industrial Revolution in the United States," *Business History Review* 46 (Summer 1972): 141-81.
- Kasson, Ch. 3 "Technology & Imaginative Freedom."
- Thoreau, "Paradise to be Regained."

WEEK SIX: THE FIRST NATIONAL SYNTHESIS:IRON, STEEL, RAILROADS

Themes:
- Schon's model: "Risk vs. Uncertainty Thinking."
- "Big Iron," "Big Steel," Railroads as a radically new transport system. Technological Momentum.

Readings:
- Morrison, "John Fritz & 3-High Rail Mill" in *From Know-How to Nowhere*, pp. 68-81.
- Larson, "Systems Approach: Railroads."
- Notes (1,2,20-24).

WEEK SEVEN: LATE 19TH CENTURY TENSIONS ABOUT TECHNOLOGY

Themes:
- Worker culture vs. Factory systems.
- Optimism vs. Pessimism in American society at large.
- Communications technologies: a glimpse at radically new technologies.

Readings:
- Gutman, "Work, Culture, and Society."
- Kasson, Ch. 5 "Technology and Utopia."

MID-TERM EXAM: INTERPRETING TECHNOLOGICAL SYSTEMS
(One week take-home)

PART TWO: FROM MIDDLE LANDSCAPE TO AMERICAN MELTING POT: 1880 - 1930

WEEK EIGHT: ELECTRIC LIGHT & POWER SYSTEMS: 1880-1915
Themes:
Edison and invention, Menlo Park: R&D Laboratory.
Money's role in emerging technology.
Load management & integration of a dynamic system.
Readings:
Hughes, "Electrification of America," pp. 124-53.
Notes (25-30).

WEEK NINE: EMERGENCE OF CORPORATE AMERICA: THE MELTING POT
Themes:
Wave of business mergers (1898-1903), Engineers as employees, R&D within corporate control, Trist's model of system analysis. (Early automobile films).
Readings:
Chandler, "Beginnings of 'Big Business'."
Notes (3,5, 31-34).

WEEK TEN: THE AUTOMOBILE IN AMERICA
Themes:
American acceptance of auto, Fordism, Petroleum Momentum.
Readings:
Automobile Notes: (1-18 and 21-32).

WEEK ELEVEN: CONSUMERISM AS THE NEW AMERICAN IDEAL
Themes:
Electricity & autos as "consumer push" systems.
Advertising's multiple impacts.
Readings:
Lowenthal, "Triumph of Mass Idols."
Hughes, "Electrification" (pp. 153-61).
Automobile Notes (pp. 19-22).
Burke, "Pulp, Pollution, and Advertising."

WEEK TWELVE: THE COMPUTER AND THE BOMB
Themes:
Nature and Origins of computer technology.
The Manhattan Project as an atypical system in America.
Readings:
Smith, "Project Whirlwind."
Hewlett, "Development in Nuclear Technology."
Notes (35-48).

WEEK THIRTEEN: THE BOMB AND THE "GREEN REVOLUTION"
Themes:
Moral issues of the Atomic Age: Trans-global frame of reference. Agriculture and International Systems of Technology, Cultural tensions in technology transfer.
Readings:
Staudenmaier, "The Green Revolution."

WEEK FOURTEEN: THE GREEN REVOLUTION & FINAL REVIEW

Themes:

We will conclude our discussion of the Green Revolution and prepare for the final exam.

Readings:

None.

Total Readings: 790 pages (Average = 56 pp/wk)

Course Chronology: The Systems Style -- See Appendix I.

The Mid-Term Exam

HIS 270

This exam is designed to see how well you are able to interpret the design AND the context of the technological systems we have studied so far.

We have studied the following seven systems:

1. Textiles (1815-1850)
2. Canals (1793-1825)
3. Steamboat Transportation (1815-1852)
4. Machine Tools (1816-1860)
5. Iron Manufacturing (1840-1860)
6. Bessemer Steel Manufacturing (1847-1875)
7. Railroads (1830-1880)

We have also studied the following themes as helps for interpretation:

1. Three phases of emerging technology (reverse salient) (Hughes Model)
2. Risk vs. Uncertainty Thinking (Schon Model)
3. Technological Momentum (Hughes, Staudenmaier)
4. The American Ideal of the Middle Landscape (Kasson)
5. Technological Optimism vs. Pessimism (Jefferson, Thoreau, Emerson, Etzler, Jervis)
6. Labor-management conflict: Factory System vs. Worker Culture (Gutman, Smith)
7. Government Regulation of Technology
8. Influence of terrain on design
9. American Ideal of Standardization
10. Transfer of Technology
11. Engineering Education

Your Task In This Exam:

Part One: Take one of the seven systems we have studied and interpret its history in the following three ways:

A) Describe the design of the system: (How does it work? What do you need to know to make it work, etc.?)

B) What factors in the American context directly influenced that design (land, politics, state of engineering, workers, economic motives, philosophical or religious ideals and world views, etc.)?

C) What kind of influence did the system have on American life after it was designed (technological, political, social impacts, etc.)?

Part Two: Do it again with a second system.

1. Title each part of the exam and precede it with an outline of what follows.
2. While writing questions B & C make sure you tell me which themes you are using to interpret your system. When you refer to any of the 11 themes indicate that theme by putting it in parentheses where pertinent. (e.g.(technology transfer) etc.)
3. USE AT LEAST FIVE OF THE ELEVEN THEMES TO INTERPRET EACH SYSTEM
4. Write as if you expect a human being to read your exam.
5. Write your name on the first page and each succeeding one.
6. Hand the exam in one week from today.

COURSE CHRONOLOGY: THE SYSTEMS STYLE

1790 1800 1810 1820 1830 1840 1850 1860 1870 1880 1890 1900 1910 1920 1930 1940 1950 1960 1970 1980

TEXTILES
[1790 ----------------------------------1860]

CANALS
[1790 -------------------------1845]

STEAMBOATS [1810----------------1852]

ROADS [1810 ------1830]

METAL WORKING [1815 ----------------------1860]

COAL [1825-------1840]

FIRST IND. REVOLUTION [1835 ---- 1850]

IRON [1810 --------------------------1860]

STEEL [1847 ----------------------1890]

RAILROADS [1830 --------------------------------1895]

TENSIONS ABOUT "PROGRESS" [1860------- 1900]

ELECTRIC LIGHT & POWER 1874 --------------- 1910]

AUTOMOBILE [1876 ------------------------------- 1940]

CONSUMERISM & ADVERTISING [1895 --------------- 1929]

COMPUTER [1910 ------------------ 1951]

THE MANHATTAN PROJECT [1940-45]

THE GREEN REVOLUTION [1943 -------------1974]

HISTORY OF TECHNOLOGY IN AMERICA I: 1776-1876

David F. Noble and Merritt Roe Smith

Program in Science, Technology and Society
M.I.T., Cambridge, Massachusetts

READINGS:
The following paperback books should be purchased:

- John Kasson, Civilizing the Machine (NY: Grossman, 1976).
- Edwin Layton, ed., Technology and Social Change (NY: Harper & Row, 1973)
- Merritt R. Smith, Harpers Ferry Armory & the New Technology (Ithaca, NY: Cornell, 1977).
- W. David Lewis, Iron and Steel in America (Greenville, DE: Hagley Museum, 1976).
- Elting Morison, From Know-how to Nowhere (NY: Basic Books, 1974).

Other volumes, from which readings are assigned, are:

- Louis C. Hunter, A History of Industrial Power in the U.S.: Waterpower (Charlottesville, VA: University Press of VA, 1979).
- Bruce Mazlish, ed., The Railroad and the Space Program (Cambridge, MA: MIT Press, 1965).
- Melvin Kranzberg and Carroll Pursell, eds., Technology in Western Civilization Vol. 1 (New York: Oxford University Press, 1967).

Information about other assigned readings listed in the syllabus will be provided the first day of class.

COURSE REQUIREMENTS:

There will be three half-hour "reading quizzes" at various intervals during the semester. The purpose of these quizzes is to test your general comprehension of the assigned reading materials and, of course, to make sure that you are doing the readings. Needless to say, it is important that you read the material assigned for each class and participate in discussions. Indeed, your final grade may be determined by this participation if you end up in a "border-line" situation.

In addition to the quizzes, each class member will be asked to prepare a term paper on some aspect of early American technology (a list of possible topics will be handed out at a later date). Preparation of the term paper will consist of three assignments. First, each member of the class is expected to hand in a brief prospectus (approximately 2 or 3 typed pages) which announces the topic, discusses how the paper will be executed and what themes will be addressed, appends a working bibliography of at least 8 sources pertaining to the topic, and briefly explains how you found these sources. The instructor will read and critique this prospectus and return it to you with comments on content, organization, analysis, and writing style. During the next six weeks you will be expected to flesh out the topic, preparing a fifteen- to twenty-page paper. Again, the instructor will read and critique the paper and return it to you for revisions. Final submission will be on the last day of class.

Term paper = 70% of the final grade
Quizzes = 30% of the final grade

TOPICS AND READING ASSIGNMENTS:

1ST SESSION:
Topic:
The craft ethos and structures of pre-industrial production, c. 1776-1815.

The class will view the film "Williamsburg Gunsmith," using it to discuss the nature of traditional craftsmanship in early America and as a point of departure for scrutinizing the momentous changes unleashed by industrialization. The class will conclude with comments about various ways of conceptualizing technology as a historical phenomenon.

Reading assignment:
Brooke Hindle, "The Artisan During America's Wooden Age," in Carroll W. Pursell, ed., Technology in America (Cambridge, MA: MIT Press, 1981), pp. 9-17.

2ND SESSION:
Topic:
Cultural contexts and technological change, c. 1776-1800.

A discussion of prevalent ideas and values in late 18th-century America and how they influenced the course of technological change and industrial development in the early republic (c. 1790-1830).

Reading assignment:
John Kasson, Civilizing the Machine, pp. 3-51.
Edwin Layton, ed., Technology and Social Change in America pp. 79-97 (Meier essay) and pp. 9-24 (Ferguson essay).

3RD SESSION: - FIRST QUIZ -
Topic:
Sectors of change, c. 1815-1840.

An examination of evolving technological systems and the changes they induced in the worlds of business, politics, and labor. Consideration will be given to the question of whether peculiar styles (regional and national) can be discerned in the emergence of new technologies and industrial organizations. Two systems will be treated this week: textiles and power.

Reading assignment:
Kasson, pp. 55-106.
Charles Sanford, "The Intellectual Origins and New Wordliness of American Industry," Journal of Economic History 18 (March 1958): 1-16.
John W. Lozier, "The Forgotten Industry: Small and Medium Sized Cotton Mills South of Boston," Working Papers from the Regional Economic History Research Center 2 (1979): 101-24.
Louis C. Hunter, A History of Industrial Power in the U.S.: Waterpower, pp. 416-80.
Field trip (optional), Slater Mill Historic Site, Pawtucket, RI.

4TH SESSION:
Topic:

Sectors of change (cont'd.), 1820-1850s.

A discussion of innovation in the firearms industry (the "American system" of manufacture), the implications of military technology, and related changes in such metalworking industries as machine tools, sewing machines, agricultural machinery, bicycles, etc.

Reading assignment:

Merritt R. Smith, *Harpers Ferry Armory and the New Technology* (Ithaca, NY: Cornell University Press, 1977), (complete).

Layton, pp. 47-63 (Woodbury essay).

5TH SESSION:
Topic:

Sectors of change (cont'd.), 1850s-1860s.

An examination of heavy industry and agriculture.

Reading assignment:

W. David Lewis, *Iron and Steel in America* (complete).

W. D. Rasmussen, "The Impact of Technological Change on American Agriculture, 1862-1962," *Journal of Economic History* 22 (December 1962): 578-99.

6TH SESSION:
Topic:

Sectors of change (cont'd.)

Transportation systems, the growth of national markets and the rise of modern business management. Consideration of the role of government in technological and economic development.

Reading assignment:

Layton, pp. 25-46 (Hunter essay) and pp. 99-120 (Burke essay);

Bruce Mazlish, ed., *The Railroad and the Space Program*, pp. 127-62 (Chandler essay) and (Cochran essay).

7TH SESSION: - SECOND QUIZ -
Topic:

The Workers' World

How the new technologies impinged on life and labor in mill villages and industrial cities, with special attention to work discipline, labor discontent, and issues of social control.

Reading assignment:

Paul Faler, "Cultural Aspects of the Industrial Revolution: Lynn, Massachusetts, Shoemakers, and Industrial Morality, 1826-1860," *Labor History* 15 (Summer 1974): 367-94.

Julian C. Skaggs and Richard L. Ehrlich, "Profits, Paternalism, and Rebellion: A Case Study in Industrial Strife," *Business History Review* 54 (Summer 1980): 155-74.

Clifford S. Griffin, "Religious Benevolence as Social Control, 1815-18[illegible]," *Mississippi Valley Historical Review* 44 (December 1957): 423-44.

8TH SESSION:

Topic:

Social contexts of industrialization

The rise of professional engineering and its implications; the Franklin Institute as a symbol of change; and the emerging ambiguity of "technology."

Reading assignment:

Elting Morison, From Know-how to Nowhere, chaps. 1-5.

9TH SESSION:

Topic:

Technology as a social process and related themes

A discussion of the labor scarcity hypothesis; styles of technology; and the patent system, with special attention to the case of the telegraph. The interfaces of science and technology in antebellum America.

Reading assignment:

Kasson, pp. 137-80.

10TH SESSION:

Topic:

Images of the machine in America

How the changes wrought by industrialization were depicted and symbolized in literature, art, and popular culture.

Reading assignment:

Nathaniel Hawthorne, "The Celestial Railroad," (complete); in Hawthorne, N., Mosses from an Old Manse (Columbus, OH: Ohio State University Press, 1974), pp. 86-206.

11TH SESSION: - THIRD QUIZ -

Topic:

Technology and the 19th-century world

A discussion of technology and the "American dream" in 19th-century America; international expositions of technology and their significance; the impact of the Civil War; and the "End of American Innocence."

Reading assignment;

Eugene S. Ferguson, "The American-ness of American Technology," Technology and Culture 20 (January 1979): 3-24.

M. Kranzberg and C. Pursell, eds., Technology in Western Civilization, Vol. 1, pp. 706-26 (Ferguson essay).

FINAL SESSION:

Topic:

Wrap-up; review of the course, major themes, and considerations.

Reading assignment: none.

HISTORY OF TECHNOLOGY IN AMERICA: SINCE 1876

David F. Noble and Merritt Roe Smith

Program in Science, Technology & Society
M.I.T., Cambridge, Massachusetts

Since this is a relatively small class, a colloquium format will be adopted in which the instructors will set the background and introduce appropriate themes at the beginning of each session as a means of initiating discussion. In order to have informed discussions, it is imperative that you do the reading on time and participate in class. Each class member will also be asked to prepare a term paper on some aspect of American technology since 1876. The term paper will be the primary determinant of the final grade. For those members of the class who wish to take a final examination, one will be given during the final exam period. This, however, is optional.

READINGS:

The following paperback books should be purchased:

Edward Bellamy, *Looking Backward* 1888. Reprint ed. (NY: Signet Classics, 1960).
David F. Noble, *America by Design: Science, Technology and the Rise of Corporate Capitalism* (NY: Alfred A. Knopf, 1977).
Glenn Porter, *The Rise of Big Business, 1860-1910* (NY: Thomas Crowell, 1973).
Harry Magdoff, *The Age of Imperialism* (NY: Monthly Review Press, 1969).
Seymour Melman, *The Permanent War Economy* (NY: Simon and Schuster 1974).
Kurt Vonnegut, *Player Piano* 1952. Reprint ed. (NY: Delacorte, 1977).
Barry Commoner, *The Closing Circle* (NY: Alfred Knopf, 1972).

Information about other assigned readings listed in the syllabus will be provided the first day of class.

TOPICS AND READINGS:

Introduction: The ambiguity of technology.

Assigned reading: Edward Bellamy, *Looking Backward*, (complete).

Part I: *A New Order, 1880-1930*

A. Setting: social and economic conditions.
Assigned reading:
David F. Noble, *America by Design*, Part I (esp. pp. 50-65, "Preservation Through Change");
Glenn Porter, *The Rise of Big Business*, (complete).

Recommended reading:
William A. Williams, "The Age of Corporate Capitalism," in Contours of American History (Chicago, IL: Quadrangle Books, 1956).

B. Technologies: electricity, chemicals, iron and steel, automobiles.
Assigned reading:
Thomas P. Hughes, Thomas A. Edison (London: Her Majesty's Stationery Office, 1976), (complete).
Lynwood Bryant, "Origins of the Automobile Engine," Scientific American 216 (March 1967): 102-12.
David Gartman, "Origins of the Assembly Line and Capitalist Control of Work at Ford," in Andrew Zimbalist, ed., Case Studies in the Labor Process (London: Monthly Review Press, 1980).
H. L. Arnold and F. Faurote, Ford Methods and the Ford Shops 1915. Reprint ed. (NY: Arno Press, 1972), (excerpt).
Recommended reading:
W. David Lewis, Iron and Steel in America (Greenville, DE: Hagley Museum, 1976).
Peter Temin, Iron and Steel in 19th-Century America: An Economic Inquiry (Cambridge, MA: MIT Press, 1964).
Allan Nevins, Ford 3 vols. 1954-63. Reprint ed. (NY: Arno Press, 1976).
Field trips: General Electric, Lynn, Massachusetts,
General Motors assembly plant, Framingham, MA

C. Technology as a social process: education, professions, research.
Assigned reading:
Noble, America by Design, Part II, esp. chaps. 3-5;
Arthur D. Little, The Handwriting on the Wall (Boston: Little, Brown & Co., 1928), pp. 3-8.
Hugh G.J. Aitken, "Science, Technology, and Economics: The Invention of the Radio as a Case Study," in E. T. Layton, W. Krohn, and P. Weingart, eds., The Dynamics of Science and Technology (Boston: Reidel, 1978).
Recommended reading:
Edwin Layton, The Revolt of the Engineers (Cleveland, OH: Case Western Reserve University Press, 1971).
Randall Birr, Pioneering in Industrial Research (Washington, DC: Public Affairs Press, 1957).
David A. Hounshell, "Bell and Gray: Contrasts in Style, Politics, and Etiquette," Proceedings of the IEEE 64 (Sept. 1976): 1305-14.

D. Technology as a social force.
1. Industry:
Assigned reading:
Alfred D. Chandler, "Mass Production," in The Visible Hand (Cambridge, MA: Harvard, 1977), pp. 240-83.
Recommended reading:
G.V. Thompson, "Intercompany Technical Standardization in the Early American Automobile Business," Journal of Economic History 14 (Winter 1954): 1-20.
Richard DuBoff, "The Introduction of Electric Power in American Manufacturing," Economic History Review 20 (December 1967): 509-18.

2. *Work and workers:*

Assigned reading:

David Montgomery, "Workers' Control of Machine Production in the 19th Century," *Labor History* 17 (Fall 1976): 458-509.

Kathy Stone, "Job Structures in the Steel Industry," *Review of Radical Political Economy* (Summer 1974).

Recommended Reading:

Harry Bravermann, *Labor and Monopoly Capital* (NY: Monthly Review Press, 1974).

Harvey Swados, *On the Line* (Boston: Little, Brown, 1957).

Daniel Nelson, *Managers and Workers* (Madison, WI: University of Wisconsin Press, 1975).

Hugh G.J. Aitken, *Taylorism at Watertown Arsenal* (Cambridge, MA: Harvard University Press, 1960).

3. *Society:*

Assigned Reading:

Thomas P. Hughes, "The Electrification of America," *Technology and Culture* 20 (January 1979): 124-61.

Joel Tarr and F.C. McMichael, "Decisions about Wasterwater Technology, 1850-1932," *Journal of the Water Resources Planning and Management Division* 103 (May 1977): 47-61.

Ruth S. Cowan, "The 'Industrial Revolution' in the Home: Household Technology and Social Change," *Technology and Culture* 17 (January 1976): 1-23.

James J. Flink, "Three Stages of American Automobile Consciousness," *American Quarterly* 24 (October 1972): 451-73.

Recommended reading:

Sam Bass Warner, *Streetcar Suburbs* (Cambridge, MA: MIT and Harvard Press, 1962).

James J. Flink, *America Adopts the Automobile* (Cambridge, MA: MIT Press, 1970).

James J. Flink, *The Car Culture* (Cambridge, MA: MIT Press, 1975).

E. Technology as idea: ambiguity of technology.

Assigned reading:

Thorstein Veblen, *Engineers and the Price System* (NY: B.W. Huebusch, 1921).

Lewis Mumford, "The Neotechnic Phase," in *Technics and Civilization* 1934. Reprint ed. (NY: Harcourt Brace & World, 1963).

George Ellery Hale, et al., "The National Importance of Scientific and Industrial Research," *Bulletin of the National Research Council* 1 (October 1919): 1-43.

John J. Carty, "Science and the Industries," Reprint and Circular Series, National Research Council (6 February 1920): 1-16.

Howard Scott, "A Rendezvous with Destiny," *American Engineer* 6 (October 1936): 8-10,24.

Recommended reading:

Charles L. Reese and A.J. Wadhams, "Industrial Benefits of Research," Reprint and Circular Series, National Research Council, No. 18 (February 1921).

Vernon Kellogg, "Isolation or Cooperation in Research," Reprint and Circular Series, NRC, No. 67 (Dec. 1925).

F.B. Jewett, "Motive and Obligation," Reprint and Circular Series, NRC, No. 68 (Dec. 1925).

Part II: *Pax Americana and the World Order, 1945-1965*

A. Setting.

Assigned reading:

- Harry Magdoff, *The Age of Imperialism*, (complete).
- Dwight D. Eisenhower, "Farewell Address" (Jan. 1961), Excerpts in Eisenhower, D.D., *Waging Peace* (Garden City, NY: Doubleday, 1965), pp. 614-16.
- John F. Kennedy, "Inaugural Address" (Jan. 1961), in Gardner, J. W., ed., *To Turn the Tide* (NY: Harper & Brothers, 1962), pp. 6-11.

B. Technologies: atomic power, cybernetics, computers, electronics, petrochemicals, aviation.

Assigned reading:

- Richard Hewlett, "The Beginnings of Development in Nuclear Technology," *Technology and Culture* 17 (July 1976): 465-78.
- Thomas M. Smith, "Project Whirlwind," *Technology and Culture* 17 (July 1976): 447-64.
- Charles Weiner, "How the Transistor Emerged," *IEEE Spectrum* 10 (Jan. 1973): 24-33.
- Frank A. Spencer, "Technology, Economics, and Corporate Strategy in U.S. Air Transportation, 1946-1973," *Business and Economic History* 7 (Feb. 1978): 11-28.
- Barry Commoner, "The Promise and Peril of Petrochemicals," *New York Times Magazine* (27 Sept. 1977).

Recommended reading:

- Richard Hewlett and Oscar E. Anderson, *The New World, 1939-1946: A History of the U.S. Atomic Energy Commission*: Vol I (University Park, PA: PSU Press, 1962).
- Richard Hewlett and Francis Duncan, *Atomic Shield, 1947-1952: A History of the U.S. Atomic Energy Commission*: Vol II (University Park, PA: PSU Press, 1969).
- Thomas P. Hughes, "ENIAC: Invention of a Computer," *Technikgeschichte* 42 (No. 2, 1975): 148-65.
- Ernest Braun and Stuart MacDonald, *Revolution in Miniature: The History and Impact of Semiconductor Electronics* (Cambridge: Cambridge University Press, 1980).

Field trips: Raytheon - MITRE Corporaion.

C. Technology as a social process.

Assigned reading:

- James P. Baxter, *Scientists Against Time* (Boston: Little, Brown & Co, 1946), (excerpt).
- Seymour Melman, *The Permanent War Economy*, (complete).
- Seymour Melman, "The Impact of Economics on Technology," *Journal of Economic Issues* 9 (March 1975): 59-72.
- David F. Noble, "Social Choice in Machine Design," in Andrew Zimbalist, ed., *Case Studies in the Labor Process* (London: Monthly Review Press, 1980).

Recommended reading:

- Daniel Kevles, *The Physicists* (NY: Knopf [distributed by Random House], 1978).
- Nancy Stern, "The Eckert-Mauchly Computers Under Public and Private Sponsorship," (1979).

Mel Horwitch, "The Emerging Complexity in Developing Large-Scale Technology: The American SST Conflict as a Case in Point," (1979).
David R. Smith, "They're Following our Script: Walt Disney's Trip to Tomorrow-land," Future (May 1978).
Edward C. Ezell and Linda Neuman Ezell, The Partnership: A History of the Apollo-Soyuz Text Project (Wash. D.C.: NASA, 1978).

D. Technology as a social force: industry, work, society.
Assigned reading:
James R. Bright, "The Development of Automation," in M. Kranzberg and C. Pursell, eds., Technology in Western Civilization, Vol. 2 (NY: Oxford University Press, 1967).
Nathan Cook, "Computer-Managed Parks Manufacture," Scientific American 232 (Feb. 1975): 22-29.
United Electrical Workers, Guide to Automation and the New Technology, (excerpts).
Film: U.S. Air Force film on N/C.
Recommended reading:
Ida Hoos, Systems Analysis: A Critique (Berkeley, CA: University of California Press, 1972).
Merle Curtis and Kendall Birr, American Technical Missions Overseas, 1838-1938 (Madison, WI: University of Wisconsin Press, 1954).
Joseph Weizenbaum, "The Impact of the Computer," Science 176 (12 May 1972): 609-14.

E. Technology as an idea: ambiguity of technology.
Assigned reading:
Kurt Vonnegut, Player Piano, (complete).
Vannevar Bush, Science--The Endless Frontier (Washington, DC: U.S. Govt. Printing Office, 1945), (excerpts).
Jacques Ellul, "The Technological Order," in C. Stover, ed., The Technological Order (Detroit: Wayne State Univ. Press, 1963).

Part III: Challenges to the World Order, 1965+: Limits, Conflicts, New Paths

A. Setting: revolution, limits to growth, ecological decay.
Assigned reading:
Barry Commoner, The Closing Circle, (complete).
Film: WGBH Nova film, "A Plague on Your Children."
Recommended reading:
Ralph Nadar, Unsafe at any Speed (NY: Grossman, 1965).
Emma Rothschild, Paradise Lost (NY: Random House, 1973).
Langdon Winner, Autonomous Technology (Cambridge, MA: MIT Press, 1977).

B. Technologies: nuclear power, semiconductors, genetic technology.
Assigned reading:
"Why Atomic Power Dims Today," Business Week (17 Nov. 1975): 98-106.
Amory B. Lovins, "Energy Strategy: The Road Not Taken?" Foreign Affairs 55 (Oct. 1976): 65-96.
David Dickson, articles on Recombinant DNA in Nature, (excerpts).

Recommended reading:
Amory Lovins, *Soft Energy Paths* (Cambridge, MA: Ballinger, 1977). Ballinger, 1977).
Robert Stobaugh and Daniel Yergin, eds. *Energy Future* (NY: Random House, 1979).
Margin E. Olsen, "Conserving Energy by Changing Societal Goals," *Illinois Teacher* (Sept.-Oct. 1976).

C. Technology as a social process.
Assigned reading:
J. Herbert Holloman, "Science, Technology, and Economic Growth," *Physics Today* (March 1963).
"Carter Plan to Spur Innovation," *Science* (Nov. 1979).
David F. Noble, "The Chemistry of Risk" (1979).
Recommended reading:
Emilio Q. Daddario, "Technology Assessment" (1967).
Ralph Nader, *Whistle Blowing*.
Andre Gorz, "Technical Intelligence and the Capitalist Division of Labor," *Telos* (Summer 1972).
Edward E. David, Jr., "Science Futures: The Industrial Connection," *Science* 203 (2 March 1979): 837-40.
Langdon Winner, "Do Artifacts Have Politics?" *Daedalus* 109 (Winter 1980): 121-36.
Ralph Nader, "The Engineers' Professional Role," *Journal of Engineering Education* 57 (Feb. 1967): 450-54.

D. Technology as a social force: energy, work, society.
Assigned reading:
A.L. Hammond, "'Soft Technology' Energy Debate: *Limits to Growth* Revisited," *Science* 196 (27 May 1977): 959-61
Bennett Kreman, "Lordstown--Searching for a Better Way of Work," *New York Times* (9 Sept. 1973).
"Excerpts from the Presidential Commission on the Accident at Three Mile Island," *Boston Globe* (4 Nov. 1979).
Mike Gray, "What Really Happened at Three Mile Island," *Rolling Stone* (17 May 1979).
Recommended reading:
Philip Kraft, *Programmers and Managers* (NY: Springer-Verlag, 1977).

E. Technology as an idea: ambiguity of technology.
Assigned reading:
United Auto Workers, "Guidelines for the Introduction and Use of New Technology," (Presentation to Ford Motor Co., Aug. 1979).
David Dickson, *Politics of Alternative Technology*, (NY: Universe Books, 1975), (excerpt).
Samuel Florman, *The Existential Pleasures of Engineering* (NY: St. Martins Press, 1976), (excerpt).
Recommended reading:
E.F. Schumacher, *Small is Beautiful* (NY: Harper & Row, 1973).

Selected Term Paper Topics:

1. History of the nuclear engineering department at MIT.
2. The industrialization of American agriculture.
3. Alternate energy programs: The politics of coal gasification.
4. Kodak, Polaroid and the development of instant photography.
5. Genetic research and social change.
6. The design process in electrical engineering systems.
7. Social effects of modern advertising.
8. Telecommunications and world order.

TECHNOLOGY AND MATERIAL CULTURE IN AMERICA, 1600-1860

Patrick M. Malone

American Civilization Program
Brown University
Providence, RI

"Technology and Material Culture in America" examines the processes, products, and social effects of American technology from 1600 to 1860. The primary goal of the course is to explain the role of technology in the development of our culture. Material culture, the body of artifacts produced by technology, both reflects and shapes the ideas and behavior patterns of Americans. Students learn to use material objects as evidence in the study of history, and they learn that technology is one of the principal forces causing historical change.

This course, open to both graduate students and undergraduates uses two slide-illustrated lectures per week with an occasional field trip or movie. There is a mid-term exam, a final exam, and an optional research paper.

American Civilization 152:

1. Introduction

2a. Material Culture and Historical Archaeology

James Deetz, *In Small Things Forgotten* (Garden City, N.Y.: Anchor Books, 1977).
Suggested: James Deetz, *Invitation to Archaeology* (Garden City, N.Y.: Natural History Press, 1967).

2b. Architecture and Building in Colonial America

Charles F. Carroll, "The Forest Society of New England." In Brooke Hindle, ed. *America's Wooden Age* (Tarrytown, NY: Sleepy Hollow Restorations, 1975), pp 13-36.
Hugh Morrison, *Early American Architecture* (New York: Oxford University Press, 1952), pp 2-48.
Dell Upton, "Traditional Timber Framing." In Brooke Hindle, ed. *Material Culture of the Wooden Age* (Tarrytown, N.Y.: Sleepy Hollow Press, 1981), pp 35-93.
Suggested: Abbott L. Cummings, *The Framed Houses of Massachusetts Bay, 1625-1725* (Cambridge, MA: Harvard University Press, 1979).

3. Architecture and Building Technology in Colonial America

Christopher Tunnard and Henry Reed, *American Skyline* (New York: New American Library, 1956), pp 32-57.
William Pierson, *American Buildings and Their Architects: The Colonial and Neo-Classical Styles* (Garden City, NY: Anchor Press, 1976), pp 111-56. Suggested: pp 1-110.
Harley McKee, *Introduction to Early American Masonry* (Washington, D.C.: National Trust for Historic Preservation, 1973), pp 41-53.

4. Early American Manufacturing

Patrick Malone, "Changing Military Technology Among the Indians of Southern New England, 1600-1677." *New England Quarterly*, 25 (March 1973): 48-63.

Arthur Bining, *Pennsylvania Iron Manufacture in the Eighteenth Century* (Harrisburg: Pennsylvania Historical and Museum Commission, 1979).

Charles Howell, "Colonial Watermills in the Wooden Age." In *America's Wooden Age*, pp 120-59.

Eugene Ferguson, *Oliver Evans, Inventive Genius of the American Industrial Revolution* (Greenville, DE: Hagley Museum, 1980), pp 9-35, 52-9.

5. Water and Steam Power

Patrick Malone, *The Lowell Canal System* (Lowell, MA: Lowell Museum Corporation, 1976).

Louis C. Hunter, "Waterpower in the Century of the Steam Engine." In *America's Wooden Age*, pp 160-92.

Ferguson, *Oliver Evans*, pp 35-51, 60-64.

Suggested: Louis C. Hunter, *A History of Industrial Power in the United States, 1780-1930: Waterpower in the Century of the Steam Engine* (Charlottesville: University Press of Virginia, 1979).

Carroll Pursell, *Early Stationary Steam Engines in America* (Washington, D.C.: Smithsonian Institution Press, 1969).

6. Architecture and Building Technology in the National Period

Tunnard and Reed, *American Skyline*, pp 58-113.

McKee, *Introduction to Early American Masonry*, pp 9-39.

Andrew J. Downing, *The Architecture of Country Houses*, 1850 Reprint ed. (New York: Dover, 1969).

Suggested: Pierson, *American Buildings and Their Architects*.

Mid-Term Exam: 24 Hour Take Home

7. Growth of American Industry and Industrial Communities

John Kasson, *Civilizing the Machine: Technology and Republican Values in America, 1776-1900* (New York: Penguin Books, 1976).

Nathan Appleton, *Introduction of the Power Loom and Origin of Lowell* (Lowell, MA: B. H. Penhallow, 1858).

Pierson, *American Buildings and Their Architects: Technology and the Picturesque, the Corporate and the Early Gothic Styles* (Garden City, NY: Anchor Press, 1980), pp 1-90.

Gary Kulik, "A Factory System of Wood: Cultural and Technological Change in the Building of the First Cotton Mills." In *Material Culture of the Wooden Age*, pp 300-35.

8. The Industrial Experience - Slater Mill Field Trip

Paul Rivard, *Samuel Slater: Father of American Manufactures* (Pawtucket, RI: Slater Mill Historic Site, 1974).

David Wilkinson, "Reminiscences." In Carroll Pursell, ed. *Readings* *in Technology and American Life* (New York: Oxford University Press, 1969.

Merritt R. Smith, *Harpers Ferry Armory and the New Technology* (Ithaca, NY: Cornell University Press, 1977), pp 17-23, 52-68, 184-251.

9a. Technology and the Worker

Herbert Gutman, *Work, Culture, and Society in Industrializing America* (New York: Vintage Books, 1977), pp 3-78.

Gary Kulik, "Pawtucket Village and the Strike of 1824: The Origins of Class Conflict in Rhode Island." *Radical History Review* 17 (1978): 5-37.

9b. Industrial Archaeology

Robert Vogel, *Roebling's Delaware and Hudson Canal Aqueducts* (Washington, D.C.: Society for Industrial Archaeology, 1973).

Theodore Penn, "The Development of the Leather Main Belt Drive." *Industrial Archeology* 7, #1 (1981): 1-14.

Larry Lankton, "Three Dimensions Reduced to Two." In Diane Newell, ed. *Symposium: Industrial Archeology and the Human Sciences.* (Washington, D.C.: Society for Industrial Archeology, 1978).

10a. Ideas and Artifacts: The Shakers

Dolores Hayden, *Seven American Utopias: The Architecture of Communitarian Socialism, 1790-1975* (Cambridge: MIT Press, 1976), pp 64-103.

Edward D. Andrews and Faith Andrews, *Work and Worship: The Economic Order of the Shakers* (Greenwich, CT: New York Graphic Society, 1974), pp 146-59.

June Sprigg, *By Shaker Hands* (New York: Alfred A. Knopf, 1975), pp. 63-76.

10b. Adaptive Reuse of Historic Structures

Tony Wrenn and Elizabeth Mulloy, *America's Forgotten Architecture* (Washington, D.C.: National Trust for Historic Preservation, 1976), pp 231-89.

11. Transportation

Mark Twain, *Life on the Mississippi* (New York: New American Library, 1961), chapters 1-30, 38.

George R. Taylor, *The Transportation Revolution, 1815-1860* (New York: Rinehart & Co., 1951), chapters 2-7.

Joseph A. Goldenberg, "With Saw and Axe and Auger: Three Centuries of American Shipbuilding." In *Material Culture of the Wooden Age*, pp 97-128.

John H. White, Jr., "Railroads: Wood to Burn." In *Material Culture of the Wooden Age*, pp 184-224.

12. Bridge Design and Construction

Richard Allen, *Covered Bridges of the Northeast* (Brattleboro, VT: Stephen Greene Press, 1974), chapters 1-4.
David Plowden, *Bridges: The Spans of North America* (New York: Viking Press, 1974), pp 9-65.
Lee H. Nelson, "The Colossus of Philadelphia." In *Material Culture of the Wooden Age*, pp 159-83.

13. Bridge Design and Construction

Plowden, *Bridges: The Spans of North America*, pp 71-119.

READING PERIOD: Merritt R. Smith, *Harpers Ferry Armory and the New Technology*, remaining pages.

Optional extra credit papers due.

Final Exam

Sample Exam Questions

Mid-Term "Take Home": 750 Word Essay

Why and in what ways did American technology and material culture in the colonial period deviate from traditional European patterns?

Final Exam: Identifications and an Essay

Identifications

The student must identify and explain the full significance of eight out of ten individuals, buildings, bridges, technical innovations, concepts, etc.

Essay

Discuss the roles of steam and water power in American industry before 1860. Compare the two sources of power and note major innovations in power technology.

TECHNOLOGY AND MATERIAL CULTURE IN AMERICA, 1860-PRESENT

Patrick M. Malone

"Technology and Material Culture in America" examines the processes, products, and social effects of American technology from 1860 to the present. The primary goal of the course is to explain the role of technology in the development of our culture. Material culture, the body of artifacts produced by technology, both reflects and shapes the ideas and behavior patterns of Americans. Students learn to use material objects as evidence in the study of history, and they learn that technology is one of the principal forces causing historical change.

This course, open to both graduate students and undergraduates uses two slide-illustrated lectures per week with an occasional field trip or movie. There is a mid-term exam, a final exam, and an optional research paper.

American Civilization 153

1. Introduction/Historical Background

Suggested: James Deetz, *In Small Things Forgotten* (Garden City, NY: Anchor Books, 1977).

2. Bridge Design

David McCullough, *The Great Bridge* (New York: Avon Books, 1972).
T. Allan Comp and Donald Jackson, *Bridge Truss Types: A Guide to Dating and Identifying* Technical Leaflet #95, (Nashville, TN: American Asso. for State and Local History, 1977).
Suggested: David Plowden, *Bridges: The Spans of North America* (NY: Viking Press, 1974).

3. Innovation and the "Systems Approach" to Technology: The Steel Industry

Elting Morison, *Men, Machines, and Modern Times* (Cambridge, MA: MIT Press, 1966).
Robert M. Pirsig, *Zen and the Art of Motorcycle Maintenance* (New York: Morrow, 1974), pp. 90-95.

4a. The Worker and Technology: Steel Rolling Mills

David Brody, *Steel Workers in America: The Nonunion Era* (Cambridge, MA: Harvard University Press, 1960), chapter 1.
John A. Fitch, *The Steel Workers* 1910. Reprint ed. (New York: Arno Press, 1969), chapter 6.

4b. Technology on the Great Plains

Walter P. Webb, *The Great Plains* (New York: Grosset & Dunlap, 1957), chapters 7-8.
Siegfried Giedion, *Mechanization Takes Command* (New York: W.W. Norton & Co., 1969), pp 130-68.

5. Architecture and Building Technology, 1860-Present

Christopher Tunnard and Henry Reed, American Skyline (New York, NAL, 1956), pp 90-210.
Mike Cherry, On High Steel (New York: Quadrangle Books, 1974).
Suggested: William Jordy, American Buildings and Their Architects: Progressive and Academic Ideals at the Turn of the Twentieth Century (New York: Anchor Press, 1976), chapter I.
John Poppeliers, et al., What Style is It? (Washington, D.C.: Preservation Press, 1977).
David Macaulay, Underground (Boston: Houghton Mifflin, 1976).

6a. The Development of a Metropolis: Boston

Sam B. Warner, Streetcar Suburbs 1962. Reprint ed. (New York: Atheneum, 1969).
Suggested: Bainbridge Bunting, Houses of Boston's Back Bay (Cambridge, MA: Belknap Press, 1967).

Mid-Term Exam: 24 Hour Take Home

6b. Boom Towns and Precious Metals

Rodman Paul, Mining Frontiers of the Far West, 1840-1880 (Albuquerque: University of New Mexico Press, 1974).
John McPhee, Coming Into the Country (New York: Farrar, Straus & Giroux, 1977), pp 220-28.
Suggested: Otis Young, Western Mining (Norman: University of Oklahoma Press, 1970).

7. Coal Mining

Harry Caudill, Night Comes to the Cumberlands (Boston: Little, Brown & Co., 1962).
Suggested: Keith Dix, Work Relations in the Coal Industry (Morgantown: West Virginia University, 1977).

8. Electricity

Harold Passer, The Electrical Manufacturers, 1875-1900, 1953. Reprint ed. (New York: Arno Press, 1972).
Henry Adams, "The Dynamo and the Virgin." In The Education of Henry Adams (Boston: Houghton-Mifflin Co., 1961).

9a. Civil Engineering on the Grand Scale: The Panama Canal

David McCullough, The Path Between the Seas (New York: Simon & Schuster, 1977).

9b. The Assembly Line

Giedion, *Mechanization Takes Command*, pp 77-126.
Eli Chinoy, *Automobile Workers and the American Dream* (Boston: Beacon Press, 1972).
Movie: *Modern Times*.

10. Tour of an Automobile Assembly Plant

Harvey Swados, *On the Line* (Boston: Little, Brown, 1957).

11. The Automobile and American Culture

James Flink, *The Car Culture* (Cambridge, MA: MIT Press, 1975).
Tom Wolfe, *Kandy-Kolored Tangerine-Flake Streamline Baby* (New York: Farrar, Straus & Giroux, 1965), chapters 2,6,8.
Suggested: Daniel Vieyra, *Fill 'Er Up* (New York: Macmillan, 1979).

12a. Technology in the Home

Giedon, *Mechanization Takes Command*, pp 512-606.
Ruth S. Cowan, "The 'Industrial Revolution' in the Home: 20th Century." *Technology and Culture* 17 (January 1976): 1-23.
William D. and Deborah C. Andrews, "Technology and the Housewife in Nineteenth-Century America." *Women's Studies* 2 (1974): 309-28.

12b. The Literary Response to American Industrialism

Mark Twain, *A Connecticut Yankee in King Arthur's Court* (New York: New American Library, 1963).

13. Course Summary

Reading Period: Tracy Kidder, *The Soul of a New Machine* (Boston: Little, Brown, 1981).

Optional extra credit papers due.

Final Exam

Sample Exam Questions

Mid-Term "Take Home": 750 Word Essay

Why did the mass production of steel have such a dramatic impact on American culture? How did the properties of steel make possible great progress in many areas of engineering?

Final Exam: Identifications and an Essay

Identifications

The student must identify and explain the full significance of eight out of ten individuals, buildings, bridges, technical innovations, concepts, etc.

Essay

Technological change produces both social costs and social benefits. By drawing evidence from the history of American mining and automobile manufacturing, discuss the effects of mechanization on health, safety, and job satisfaction of workers.

SECTION III.

THEMES IN THE HISTORY OF TECHNOLOGY AND TECHNOLOGY STUDIES

TECHNOLOGY, SOCIAL CHANGE AND THE ROLE OF WOMEN

Daryl M. Hafter

Department of History and Philosophy
Eastern Michigan University
Ypsilanti, Michigan

A. Rationale:

This course explores the role of technology as it has evolved through time and its effect on human lives. Studying a relatively new field of academic research, History 525 will show how changing technology has altered women's roles. It will bring to our students' consideration a timely approach to some of the important questions of the past and present. It is one of the required courses for the Women's Studies Masters of Arts in Liberal Studies.

B. Course goals and objectives:

History 525 will enable students to learn about the history of technology and the way technological change impinges on human development. Through readings, lectures, and audiovisual materials, this course will teach how women influenced technological change by developing new technologies themselves, or by their choice of work. Current problems growing out of modern technology will be explored against the historical backdrop.

C. Description:

This course will examine the nature and origins of technology, the influence of its historical development from classical to modern times on women in the United States and Europe, and problems stemming from current technological advance.

Required Texts:

John G. Burke and Marshall C. Eakin, eds., *Technology and Change* (San Francisco: Boyd and Fraser, 1979).
Melvin Kranzberg and Carroll W. Pursell, Jr., eds.,*Technology in Western Civilization* Vol. I (New York: Oxford Univesity Press, 1967).
Martha Moore Trescott, ed., *Dynamos and Virgins Revisited: Women and Technological Change in History* (Metuchen, NJ: Scarecrow Press, 1979).
Jean Gimpel, *The Medieval Machine: The Industrial Revolution of the Middle Ages* (Harmondsworth, England: Penguin Books, 1977).

Topics and Readings

1. The Nature of Technology: An Overview and Contrasting Views

Melvin Kranzberg and Carroll W. Pursell, Jr., "The Importance of Technology in Human Affairs," in M. Kranzberg and C. Pursell, eds., *Technology in Western Civilization* (hereafter cited as TIWC), ch. 1.

Jacques Ellul, "The Technological Order," in J. Burke and M. Eakin, eds., Technology and Change (hereafter cited as TAC), pp. 13-19.

2. The Origins of Technology and Society

Peter Drucker, "The First Technological Revolution and Its Lessons," in TAC, pp. 39-46.

Nancy Tanner and Adrienne Zihlman, "Women in Evolution, Part I: Innovation and Selection in Human Origins," Signs 1 (Spring 1976): 585-608.

R. J. Forbes, "The Beginnings of Technology and Man," and "Mesopotamian and Egyptian Technology," in TIWC, chs. 2,3.

3. Technology and Society from Classical to Early Modern Times

A. G. Drachmann, "The Classical Civilizations," in TIWC, ch. 4.

Lynn White, Jr., "Technology in the Middle Ages," in TIWC, ch. 5.

Jean Gimpel, The Medieval Machine.

Daryl M. Hafter, "Agents of Technological Change: Women in the Pre- and Post-Industrial Workplace," in Dorothy G. McGuigan, ed., Women's Lives: New Theory, Research and Policy (Ann Arbor: University of Michigan, 1980), pp. 159-68.

A. Rupert Hall, "Early Modern Technology, to 1600," and "Cultural, Intellectual, and Social Foundations, 1600-1750," in TIWC, chs. 6, 7.

Shepherd B. Clough, "Economic and Political Developments, 1600-1750," in TIWC, ch. 8.

G. E. Fussell, "The Agricultural Revolution, 1600-1850," in TIWC, ch. 9.

Silvio A. Bedini and Derek J. DeSolla Price, "Instrumentation," in TIWC, ch. 11.

Carlo M. Cipolla, "Clocks and Culture," in TAC, pp. 60-64.

4. The Industrial Revolution in Europe and America

Melvin Kranzberg, "Prerequisites for Industrialization," in TIWC, ch. 13.

Abbott Payson Usher, "The Textile Industry, 1750-1830," in TIWC, ch. 14.

Eric Lampard, "The Social Impact of the Industrial Revolution," in TIWC, ch. 18.

Susan Levine, "Ladies and Looms: The Social Impact of Machine Power in the American Carpet Industry," in Martha Moore Trescott, ed., Dynamos and Virgins Revisited: Women and Technological Change in History (Metuchen, NJ: Scarecrow Press, 1979), pp. 67-76, (hereafter cited as Dynamos).

Judith A. McGaw, "Technological Change and Women's Work: Mechanization in the Berkshire Paper Industry, 1820-1855," Dynamos, pp. 77-99.

5. Invention as Technical and Social Act

Lynn White, Jr., "The Act of Invention," TAC, pp. 379-92.

John B. Rae, "The Invention of Invention," in TIWC, ch. 19.

Deborah J. Warner, "Women Inventors at the Centennial," in Dynamos, pp. 102-19.

Daryl M. Hafter, "The Programmed Brocade Loom and the Decline of the Drawgirl," Dynamos, pp. 49-66.

Eugene S. Ferguson, "Nonverbal Thought in Technology," TAC, pp. 400-405.

John Jewkes, David Sawers and Richard Stillerman, "The Sources of Invention," TAC, pp. 406-16.

6. The Maturation of Industrialization and Women's Work

Herbert Heaton, "The Spread of the Industrial Revolution," in TIWC, ch. 30.

Nathan Rosenberg, "The Economic Consequences of Technological Change," in TIWC, ch. 23.

Hugo A. Meier, "Technology and Democracy, 1800-1860," in TAC, pp. 211-13.

Susan J. Kleinberg, "Technology and Women's Work: The Lives of Working Class Women in Pittsburgh, 1870-1900," Dynamos, pp. 185-204.

Joan Scott and Louise Tilly, "Women's Work and the Family in Nineteenth-Century Europe," Comparative Studies in Society and History 17 (January 1975): 36-64.

7. Technology and the Modern Home

Ruth Schwartz Cowan, "The 'Industrial Revolution' in the Home," TAC, pp. 276-82.

Seigfried Giedion, "Engineering the Household," TAC, pp. 273-75.

Joan Vanek, "Household Technology and Social Status: Rising Living Standards and Status and Residence Differences in Housework," Technology and Culture 19 (July 1978): 361-75.

William D. Andrews and Deborah C. Andrews, "Technology and the Housewife in Nineteenth Century America," Women's Studies 2 (No. 3, 1974): 309-28.

8. Technology, Leisure, and Gender

Carroll Pursell, Jr., "Toys, Technology and Sex Roles in America, 1920-1940," Dynamos, pp. 252-68.

John F. Kasson, "Coney Island: A Case Study in Popular Culture and Technological Change," Journal of Popular Culture 9 (Spring 1976): 960-75.

M. Kaplan and Philip Bosserman, eds. Technology, Human Values and Leisure (Nashville, TN: Abingdon Press, 1971).

9. Technological Utopias

Howard Segal, "The Feminist Technological Utopia: Mary E. Bradley Lane's Mizora (1890)," Alternative Futures 4 (Spring/Summer 1981): 67-72.

Ruth Schwartz Cowan, "From Virginia Dare to Virginia Slims: Women and Technology in American Life," Dynamos, pp. 30-44.

John A. Hostetler, "Amish Society," TAC, pp. 168-74.

10. High Technology and Women's Employment

Joan Rothschild, "A Feminist Perspective on Technology and the Future," *Women's Studies International Quarterly* 4 (No. 3, 1981): 65-74.

Herbert Simon, "What Computers Mean for Man and Society," in *TAC*, pp. 68-76.

Robert H. Guest, "Scientific Management and the Assembly Line," in *TAC*, pp. 98-106.

John H. Broomfield, "High Technology: The Construction of Disaster," *Alternative Futures* 3 (Spring 1980): 31-44.

11. Technology vs. Humanistic Goals

Ralph Nader, "Unsafe at Any Speed," in *TAC* pp. 290-96.

Barry Commoner, "Are We Really in Control?" in *TAC*, pp. 6-10.

Donald Marlowe, "Public Interest--First Priority in Engineering Design?" in *TAC*, pp. 297-301.

Langdon Winner, *Autonomous Technology: Technics-out-of-control as a Theme in Political Thought* (Cambridge, MA: MIT Press, 1977).

12. Alternative Technologies and How to Get There

Wilson Clark, "Intermediate Technology," in *TAC*, pp. 198-202.

Judy Smith, "Something Old, Something New, Something Borrowed, Something Due: Women and Appropriate Technology," (Missoula, Montana: National Center for Appropriate Technology, 1979), obtained from Women & Technology Network, 315 S. 4th E.; Missoula, Montana 59801; (406)728-3941.

Harvey Brooks, "Technology Assessment in Retrospect," in *TAC*, pp. 465-76.

David Dickson, *Alternative Technology and the Politics of Technical Change* (London: Fontana, 1974), *passim*.

Bibliography

Aldridge, Alexandra, ed., "Women and the Future," Special Issue. *Alternative Futures* 4 (Spring/Summer 1981): 1-206.

Anderson, Michael, "Household Structure and the Industrial Revolution: Mid-Nineteenth Century Preston in Comparative Perspective," in Peter Laslett and Richard Wall, eds., *Household and Family in Past Time* (Cambridge: University Press, 1972).

Baker, Elizabeth, *Technology and Women's Work* (New York: Columbia University Press, 1964).

Boorstin, Daniel J., *The Republic of Technology: Reflections on our Future Community* (New York: Harper and Row, 1978).

Braverman, Harry, *Labor and Monopoly Capital: The Degradation of Work in the Twentieth Century* (New York: Monthly Review Press, 1974).

Brown, Judith C. and Goodman, Jordan, "Women and Industry in Renaissance Florence," *Journal of Economic History* 40 (March 1980): 73-81.

Charles-Roux, Edmonde, *et al.*, *Les Femmes et le Travail du Moyen Age a Nos Jours* (Paris: Editions de la Courtille, 1975).

Cipolla, Carlo, *Before the Industrial Revolution: European Society and Economy, 1000-1700* (New York: Norton, 1976).

Clark, Alice, *The Working Life of Women in the Seventeenth Century* (London: Routledge, 1919).

Clarkson, L. A., *The Pre-Industrial Economy in England, 1500-1750* (London, Batsford, 1971).

Cohen, Miriam, "Italian-American Women in New York City, 1900-1950; Work and School," in Milton Cantor and Bruce Laurie, eds., *Class, Sex and the Woman Worker* (Westport, CN: Greenwood Press, 1980).

Commoner, Barry, *The Closing Circle: Nature, Man, and Technology* (New York: Knopf, 1971).

Cooper, Grace R., *The Sewing Machine: Its Invention and Development* (Washington, DC: Smithsonian, 1976).

Cowan, Ruth Schwartz, "Two Washes in the Morning and a Bridge Party at Night: The American Housewife Between the Wars," *Women's Studies* 3 (1976): 147-72.

__________, *More Work for Mother: The Ironies of Household Technology* (New York: Basic Books, 1983).

Delesalle, Elaine, *Le Travail de la femme dans l'industrie textile et du vetement de l'arrondissement de Lille* (Lille: Imprimerie Danel, 1952).

Dorf, Richard C. and Hunter, Yvonne L. eds., *Appropriate Visions: Technology, the Environment, and the Individual* (San Francisco: Boyd and Fraser, 1978).

Dublin, Thomas, *Women at Work: The Transformation of Work and Community in Lowell, Massachusetts, 1826-1860* (New York: Columbia University Press, 1979).

Ellul, Jacques, *The Technological Society* (New York: Vintage Books, 1964).

Guilbert, Madelein, *Les Fonctions des femmes dans l'industrie* (Paris, The Hague: Mouton, 1966).

Habbakkuk, H. J., *British and American Technology in the Nineteenth Century: The Search for Labour-Saving Inventions* (Cambridge: University Press, 1962).

Hayden, Dolores, *The Grand Domestic Revolution: A History of Feminist Designs for American Homes, Neighborhoods, and Cities* (Cambridge, MA: MIT Press, 1981).

Hellman, Hal, *Technophobia: Getting Out of the Technology Trap* (New York: M. Evans & Co. 1976).

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Smith, Merritt Roe, *The Harper's Ferry Armory and the New Technology: The Challenge of Change* (Ithaca, NY: Cornell University Press, 1977).

Strasser, Susan, *Never Done: A History of American Housework* (New York: Pantheon Books, 1982).

Sullerot, Evelyne, *Histoire et sociology du travail feminin* (Paris: Gonthier, 1968).

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THE AUTOMOBILE IN AMERICA, 1890-1980: BUSINESS, CITIES, AND POLITICS

Mark H. Rose

The Program in Science, Technology, and Society
Social Sciences Department
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Work in this course will focus on the development of the automobile in the United States. Readings, lectures, and papers will develop two themes. We will examine the development of the automobile as a component in the national transportion picture, looking at the manner in which American values, the economy and business scenes, urban patterns, and politics (culture, broadly speaking) have shaped the development of transportation and the automobile in particular. At the same time, we will assess the significance of nearly unlimited automobile travel on the shaping of institutions such as the family, business, government, and so forth. Ultimately, this course is intended to highlight the roles of politics, economics, and cultural values in directing the growth of the American transportation system and the role of the automobile as well as rail and truck transport networks as they influenced the historical frameworks of contemporary American life. Let's hit the road.

Required Readings (available at the bookstore in paper)

- James J. Flink, *The Car Culture* (Cambridge, MA: MIT Press, 1975).
- John K. Galbraith, *New Industrial State* 1967. 3rd. rev. ed. (NY: NAL, 1978).
- *Reserve Readings* (available in the reserve section of the library).
- Blaine W. Brownell, "A Symbol of Modernity: Attitudes Toward the Automobile in Southern Cities in the 1920s," *American Quarterly* 24 (March 1972): 20-44.
- Mark S. Foster, "The Model-T, the Hard Sell, and Los Angeles's Urban Growth: The Decentralization of Los Angeles during the 1920s," *Pacific Historical Review* 44 (November 1975): 459-84.
- Clay McShane, "Transforming the Use of Urban Space: A Look at the Revolution in Street Pavements, 1880-1924," *Journal of Urban History* 5 (May 1979): 279-307.
- Mark H. Rose, *Interstate: Express Highway Politics, 1941-1956* (Lawrence, KS: University Press of Kansas, 1979).

Term Paper

Each student will submit a term paper that focuses on an aspect of the automobile in historic America. I will discuss sources and topics in class, but you might begin to think about and read in one of the following areas: Explain the significance of the automobile in the development of the summer and winter recreational industries in Michigan and/or nearby states, 1920-1970. The automobile industry has served as a major employer of engineers, and you might want to explore 1) the changes made in engineering education to prepare students for a place in the industry; or 2) the extent and contents of the influence of engineers in automotive design and marketing;

or 3) the content and influence of engineers and engineering ideas in the organization and management of auto firms and the automotive industry. The auto has facilitated changes in the size and density of cities, perhaps contributing to the collapse of mass transit systems. Investigate the place of the auto in your home town, focusing, say, on the decentralization of retailers, manufacturers, and households. Did these changes affect transport expenses or alter chances of finding a job?

You may prepare this paper in the form of a report to the head of a public or private agency or businss firm who is seeking a background on a phase of the auto industry on which he/she will make a policy choice. It is not necessary, if you use this format, to bring your research up to 1980. Finally, papers should be typed, double-space; submit an outline and bibliography during the fourth week and two copies of the paper during the ninth.

Exams

A quiz (20 minutes) is scheduled for the third week, and a mid-term (50 minutes) for the fifth. A final exam will be scheduled during final exam week.

Walking Tour

Provided that the weather and our schedule cooperate, we will walk through parking lots and along city streets, seeking to review the role of the auto in shaping the pace and patterns of historic Hancock-Houghton. Look, for instance, at the new road behind Tech, and ask what and who were there before it was built? Did "suburbs" surround Hancock-Houghton in the days of the electric trolley? What was/is the significance of the auto in the routines of Tech students? Do we learn anything about them by studying their cars?

The larger dimension underlying this exercise as well as the term paper is that I want to encourage you to review technological systems such as the automobile as expressions of social, economic, and political practices; I would also like you to join me in reviewing the role of historic engineering and business practices in the auto and other transport industries in shaping historical, social, economic, and political environments.

Class Schedule

Week 1. Class organization; American values and the popularity of the automobile.

Weeks 2-3. Travel and Transport Before the Auto
- Railroads and the bicycle "craze"
- Early Days of Motoring: The Auto, the Family, and Recreation
  - The vagabond and middle-class self-perceptions
  - From campfire to motel
  - White Tower hamburgers: a middle landscape for non-motorists

Note: Quiz, week 3

Week 4. Building the Automobile Industry, 1880-1925
- From Billy Durant to Alfred Sloan
- GM: Changes in marketing, finance, accounting, and organization
- Henry Ford: Industrialist and folk hero

Note: term paper outline and bibliography due

Week 5. The Auto Industry in the National Economy
- Technological Innovation in a leading sector, 1894-1930
- The innovators in the Great Depression: New designs and a New World
- The innovators in World War II: Who won the war?
- Note: Mid-term exam

Week 6. Working for the Big Three
- The line employee in 1915, 1935, and 1950
- Competing with the Auto Industry
  - The railroads and the ICC, 1887-1916
  - The railroads in WWI: Coal, zones, strikes, and shortages
  - New Deals for Truckers and Railroaders

Weeks 7-8. The Auto in the City, 1900-1935
- Early dissatisfaction with the trolley
- The trolley and decentralization
- Urban reform and personal reform: Moving out to the rim
- The rearrangement of the auto city, 1900-1935

Weeks 9-10. The Auto in the Suburbs and Central City
- Suburbanism as a way of life
- Building More Roads, 1939-1960: Highway and Auto Enthusiasts in Politics
  - The view from the suburbs
  - The view from the state highway department: Designing roads and political designs
  - Presidents, economists, and the Interstate System
- The National Transport Picture in the 1960s and 1970s
  - Energy shortages, pollution, and urban ordering
  - Investment, innovation, thermal inversions, and the political and social systems
- Note: Term paper due week 9

Note: Final exam during final exam week.

Reading Schedule

Weeks 1-3
- Flink, pp. 1-112.
- Galbraith, pp. 1-115.

Weeks 4-5
- Flink, pp. 113-233.
- Rose, pp. 1-14.
- Galbraith, pp. 116-96.

Weeks 6-7
- Brownell, pp. 20-44.
- Foster, pp. 459-84.
- McShane, pp. 279-307.
- Galbraith, pp. 197-269.

Weeks 8-10
- Galbraith, pp. 270-414; optional, pp. 415-26.
- Rose, pp. 55-68.

Thanks for riding with me!

TECHNOLOGY AND AMERICAN CITIES, 1850-1980

Mark H. Rose

The Program in Science, Technology, and Society
Social Sciences Department
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Work in this course will focus on the historical dimensions of technological systems in urban settings. The instructor will organize lectures and readings around two themes. In the first, he will ask students to concentrate on physical growth, population increases, and the subsequent changes in the ordering of populations in urban space, arguing that transport technologies such as the trolley car and later the automobile and street systems permitted urbanites to reconstruct land uses. This portion of the course, then, examines the areal and physical city. The second theme directs the attention of students to the internal development of central gas and electric plants and water and sewer networks and then shifts to an assessment of their significance for family organization, job content, and labor force structure. This portion of the course, then, explores both the internal development of technical systems and their relationship to social patterns in cities. The instructor will contend, moreover, that the new urban technologies -- as systems chiefly -- facilitated the development of the nucleated city of the twentieth century and at the same time served those who wished to exercise traditional ideals such as personal autonomy through detached housing in homogeneous neighborhoods. Altogether, this course should encourage an examination of the values, technologies, and decisions which shape urban environments, promoting change in some features and persistence of other facets of the social and physical scenes in urban arenas.

REQUIRED READINGS

Books* (*available in paper)

- *C. Condit, *Chicago, 1930-1970: Building, Planning, and Urban Technology* (Chicago: University of Chicago Press, 1974).
- *D. Katzman, *Before the Ghetto: Black Detroit in the Nineteenth Century* (Urbana: University of Illinois Press, 1973).
- *R. Simon, *The City Building Process: Housing and Services in a New Milwaukee Neighborhood* (Phila.: American Philosophical Association, 1978).

EXAMS

A mid-term examination is scheduled for the fifth week; and a final examination for final exam week. Both will be essay in format.

TERM PAPER

Each student will prepare a paper which focuses on the historic development of a technological system such as a telephone network, water works, sewerage treatment plant, or central electric and gas plants and on its social, economic, or political significance in one or perhaps two cities. Comparative work -- two cities -- is particularly welcome. Additional topics and sources will be discussed in class.

A short outline of the paper and bibliography are due during the third week, and the paper is due at the end of the ninth week. Each submission must be typed, double spaced, and the text of the final paper should run about 8-10 pages in length.

WALKING TOUR

Provided that the weather and our schedule cooperate, we will also take a walking tour (roughly one hour in length) of one or two areas near the University, looking at the location of roads and railroads, offices and homes, at building materials, and at the relationship between technologies and social patterns in urban settings.

LECTURE AND READING SCHEDULE

- Week 1 -- Class organization; core values; technological innovation, and economic growth; what is a city? What happens to urban dwellers?
- Week 2 -- The growth and arrangement of "walking cities:" New York, Philadelphia, and San Francisco before the electric trolley, social patterns in walking cities.
- Weeks 3-4 -- Transportation technologies and the reversal of the urban order: bicycles, streetcars, automobiles and the creation of the suburbs; "strip" development.
- Weeks 5-6 -- Light, Heat, and Power Systems: The growth of electric and gas plants, the centralization of employment in the energy intensive industries, and the simultaneous "nucleation" of the older, urban centers.
- Week 7 -- Water, sewers, and street systems: Values, technology and the shaping of the external, built environment.
- Week [illegible] -- Social patterns in the high-technology cities of the twentieth century; Work: separation of employment and housing; Family life: housing and the sequestration of families; domestic technologies and family patterns; the intensification of the private tradition.
- Week 9 -- Politics, cities and technology: Public Uses of the urban technologies; New Deals for housing, sewers, and roads, and planning for urban America
- Week 10 -- The city since World War II: Technology, functionality, and privacy and the limiting of obligation; prospects for environmental planning; is every American an urbanite?

READING SCHEDULE

Weeks 1- 4:	Katzman, pp. 3-134. Condit, pp. 3-177.
Weeks 5- 6:	Katzman, pp. 135-311. Condit, pp. 178-290.
Weeks 7-10:	Simon, All.

Final Exam

SS364: Technology and American Cities, 1850-1980

Winter Quarter, 1980-1981

Residents in every American city have made decisions about the siting of their homes and businesses and the level of public and private services for which they were willing to pay. Between 1850 and 1980, what took place was a vast reordering of businesses, homes, and jobs, all producing vastly reshaped urban places which influenced in basic ways the scope and quality of life for each citizen. In the first place it is vital to explain the urge to move, including, perhaps, rational economic calculations, ideas about the good life, commitments to family solidarity, membership in subcultural groups, the idea of privacy and the idea of environmental control, and the promise of plenty for all who worked hard. At the same time, you should explain the role played by technological systems, especially streetcars, highways and automobiles, central gas and electric plants, sewer and water lines, in facilitating urban and social change. Next, you should highlight the role of public officials and city planners who attempted to redirect urban land uses with a view toward promoting local and regional economic growth and social harmony. In brief, you should write a history of the formation of urban environments -- physical and social -- one which takes into account values, technologies, and decisions.

NOTE: Include material in assigned readings and lectures; it will prove helpful to think in terms of specific cities, specific decisions.

Five pages, typed, double spaced -- due noon, February 25, in the Department of Social Sciences. Please write 364 boldly at the top.

Good luck. Many thanks and best wishes.

THOMAS JEFFERSON'S INTERESTS IN SCIENCE AND TECHNOLOGY

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This course satisfies the requirement in engineering curricula for a "Humanities 2XX course" involving a study in the humanities offering a perspective on technology, and meeting the area requirement for writing and speaking assignments. The course is open to any undergraduate student in the University as an elective.

The course addresses four central questions:

1. To what extent and in what depth was Thomas Jefferson interested in science and technology?
2. What did Thomas Jefferson contribute to the development of American science and technology?
3. How did Jefferson's interests in science affect his life and works?
4. What cautions do modern scholars need to observe in studying Jefferson's interests in science?

Each of these questions invites further probing, depending upon the interests of the individual. For example, in previous offerings of this class students have asked: was Jefferson really familiar with the best science of his day? What did he and his contemporaries mean by 'science'? What were the scientific communities in which he participated, and what were they like? How do we understand his claims that the agrarian life is better than urban? Where and how did Jefferson learn about science? What legacy has America from his injection of scientific thought in the solution of public problems? Why did his own farming efforts not succeed? What did he know in depth about any area of science?

Such general questions help to organize one's thinking processes when reading extensively in historical materials, and each student is encouraged to develop his or her own list of interesting questions. During the course, each student will be expected to read the assigned texts and a considerable amount of material in Jefferson's own statements.

Each student will be expected to become familiar with the following:

1. The major phases of Jefferson's life.
2. The ways he expressed his views on scientific interests: with whom, when, where, and in what form.
3. The importance of encyclopedic knowledge as contrasted to specialization in his thought.
4. The particulars of his interest and knowledge on some topic of science or technology.

The course includes three major types of activity that support these objectives and supplement regular class meetings:

1. Assigned readings.
2. Visiting lecturers and local site visits to research centers.
3. Independent study by individuals or small groups on particular areas of Jefferson's interests.

Course credit is based upon participation in these activities, upon the reporting in written and oral form on independent research, and on assignments that are equivalent to quizzes on assignments, plus a final examination.

Credit distribution will be based on the following scale:

Quizzes (or equivalent assignments)	15%
Research paper	
proposal	5
completed paper	30
oral presentation	20
Class participation	15
Final examination	15
Total	100%

Additional credit will be given for approved reading, beyond assignments and the research paper, at a rate of 1% for each 200 pages, to a limit of 5%.

Assigned texts:

Required for all courses in the Humanities sequence for engineering students:

A good college dictionary
Charles T. Brusaw, Gerald J. Alred and Walter E. Oliu, BUSINESS WRITER'S HANDBOOK (Second edition) (NY: St. Martins Press, 1982).

These two books are listed for reference. Students who have completed Humanities 101 should have them.

For Humanities 201:

Jefferson, Thomas, Notes on the State of Virginia, William Peden, ed. (NY: W. W. Norton, 1954).

The Portable Thomas Jefferson, Merrill D. Peterson, ed. (NY: Viking Press, 1975).

Boorstin, Daniel, The Lost World of Thomas Jefferson. 1948. reprint ed. (Chicago: Univ. of Chicago Press, 1981).

Mitchill, Samuel L., A Discourse on the Character and Services of Thomas Jefferson as a Promoter of Natural and Physical Science. 1826. (Republished with Introduction by O. Allan Gianniny, Jr., Division of Humanities, 1982. Available at Newcomb Hall Bookstore only.)

Schedule of Class Meetings, Activities, and Assignments

Week 1. Introduction to course: initial review of objectives. Review syllabus to show nature of the course. Assign all work for the semester by syllabus. Discuss student response to course plan. Assignment for this week: get texts and start reading introductions and prefaces to all texts, for overall view of Jefferson's interests in science and technology. What was the extent and depth of Jefferson's interest in this area? Using introductions to the texts, develop a biographical sketch of Jefferson, with emphasis on science and technology in his public life. Assignment for next week: read NOTES ON THE STATE OF VIRGINIA, (all, with special emphasis on queries 1 2, 6, 8, 11, 13, 15, 17, 18, 19, 20, and 21.)

Week 2. Discuss Jefferson's use of "science" in NOTES. Was this the knowledge needed to govern a wartime "big" Virginia? Introductory lecture Monday; student panel discussion of Jefferson's views from queries 2-7. Assignment: complete reading of NOTES.

Week 3. Second panel on Jefferson's sense of "science" related to politics and government as shown in NOTES, queries 8-16. Wednesday, third panel, on Jefferson's sense of science related to social customs and mores, from NOTES, queries 17-23. One-hour take-home quiz on notes, to be turned in on next Monday. Assignment: read letters in Peterson for next week.

Week 4. How did Jefferson show his interest in science through his correspondence? (Peterson: pp. 349, 361, 380, 386, 392, 398, 400, 423, 434) Monday references. Wednesday, continue discussion, using Peterson: 444, 477, 482, 499, 509, 511, 517, 525, 547, 569, 577. Wednesday discussion will be led by the fourth panel.

Week 5. To what sources of information does one appeal in research on Jefferson and science? Visiting lecturer, Dr. Robert Rutland, editor, Papers of James Madison. Assignment for this week: at Alderman Library, locate at least four collections of the papers of Thomas Jefferson: those edited by Thomas Jefferson Randolph (1829), Paul Leicester Ford (1894), Lipscomb and Bergh (1903), and Julian Boyd (1948-1982). Read Jefferson's draft of the Declaration of Independence in each as a basis for comparing the editorial differences. Wednesday: visit Manuscript and Rare Books Departments of Alderman Library to meet staff and see materials available. Assignment for next Monday: use library sources to find at least one unpublished document, rare book, or microfilm copy of a Jefferson document that relates to a topic that interests you. Report your search, including index, card catalog search, etc. in a one-page summary. Prepare a bibliographic entry for your item and a 50-word abstract or precis of its contents related to your interest. (This is quiz No. 2, due, pledged, next Monday at class time.)

Week 6. Discuss individual research topics. Review topics to show what extended arguments are suggested and the sources likely to be needed. Continue this review on Wednesday, using Brusaw for principles of organization, introduction, and conclusion. These will be discussion sessions on planning research and thinking about reporting problems from the outset.

Week 7. Discuss Monticello as a working farm --an illustrated lecture on Jefferson's use of scientific and technological innovations in an agrarian setting. Wednesday (date to be confirmed) field trip to Monticello (2:00-5:00 p.m.). Assignment for next week: read Mitchill, DISCOURSE.

Week 8. Lecture-discussion: What were Jefferson's contributions to the advancement of science and technology? Research day: individual conferences as scheduled.

Week 9. Lecture-discussion: Continuing review of Jefferson's contributions to science and technology: his public policies and private practices. Sources Mitchill, Proceedings of the American Philosophical Society (1943, commemorating the bicentennial of Jefferson's birth), and Edwin T. Martin, Thomas Jefferson: Scientist (NY: St. Martins Press, 1952). Wednesday, conference with instructor on research in progress. Assignment for Nov. 8: read Boorstin, Lost World of Thomas Jefferson, chs. 1-2.

Week 10. Lecture-discussion: A puzzle-- In Jefferson's view, if man is a work of nature, what reasonable basis is there for proposing equality? (based on Boorstin, chs. 1-2). Wednesday: Review of reseach paper outlines in class and in conference. Assignment for next Monday: read Boorstin, chs. 3-4.

Week 11. Lecture-discussion: physiology as the basis for understanding man and society, based on Boorstin, chs. 3-4. Wednesday: research day. Conferences with instructor as scheduled. Presentation schedule to be completed by Wednesday, allowing each student 10-12 minutes for oral report of his or her work.

Week 12. Oral reports of research.

Week 13. Oral reports of research. Written reports due Wednesday at class time.

Week 14. Monday: complete oral presentation of research reports. Wednesday: recapitulation for examination. Suggestions for continuing research; course evaluation.

Final examination, according to University schedule.

SCIENCE, TECHNOLOGY AND HUMAN VALUES

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Preamble: This course is designed primarily for science and engineering students with no previous background in philosophy who wish to take a humanities elective in philosophy that is related to their main field of interest. We shall examine some influential attempts to understand and evaluate the role of technology in modern society. The sort of understanding that I have in mind is of a second-order variety. One can, of course, understand technology by being a technologist (by training as an engineer, say, and practicing as one) or by being concerned with technology in its day to day applications or by simply being, as we all are, a consumer of technological products in the most technologically oriented society in the world. With this first-order sort of understanding one has the advantage of direct experience and personal involvement, but it may be rather difficult to express in words and defend by arguments what one is supposed to know about technology. Often one's supposed knowledge consists of little more than scarcely articulated attitudes and unexamined feelings. All this serves to underscore the point that it is not always those who are directly and intimately involved in an activity who are best able to analyze its broader ramifications or to think reflectively about it. Second-order knowledge is knowledge about first-order activities. This distinction is long familiar to philosophers of science who distinguish the doing of science by scientists from the critical examination of that activity by philosophers and by scientists themselves. Similarly there is law and philosophy of law. Both kinds of knowledge have their value. Concentration on the second-order kind is not meant to imply that the first-order kind is inferior. Both kinds are indispensable to a full appreciation of any rational human activity.

Despite its title, we shall have relatively little to say in this course about science narrowly construed as "pure" research. The main focus of attention is on *technology* and human values. The reason for largely ignoring science is that it is not as clear as it is in the case of technology that values do play a significant role in science. Or, to put the point more precisely, it is controversial whether the values which are involved in the scientific enterprise are anything but purely *epistemic* in character. By "purely epistemic in character" I mean having to do solely with our interest in truth and the acquisition of knowledge. The standard view until quite recently has been that science, unlike technology, is *autonomous*. That is to say that the acceptance and rejection of scientific theories is, and should be, governed by the internal norms of scientific rationality independent of ethical and other value judgments. For many philosophers of science this restriction of scientific decisions to purely epistemic considerations is one of the touchstones of scientific rationality and objectivity and serves to demarcate science from technology on the one hand and from pseudo-science on the other. (A central paper in this debate, attacking the thesis that science is autonomous, is R. S. Rudner, "The Scientist *qua* Scientist Makes Value Judgments," *Philosophy of Science* 20 (Jan. 1953): 1-6. For a recent defense of Rudner's position based on additional arguments and providing a useful overview of the debate, see J. C. Gaa, "Moral Autonomy and the Rationality of Science," *Philosophy of Science* 44 (Dec. 1977): 513-41. These and related issues are explored in the companion course to this one, *Conflicts and Values in Science*.) But when we turn to consider technology, it is plausible to argue that it follows from the very nature of technology that human values play an essential role in shaping its character and direction. Technology is teleological or goal-oriented. Its primary aim is to satisfy human needs and desires in an acceptable and efficient fashion. (There are, of course, serious questions about which desires ought to be satisfied, which needs are genuine, whose interests are in fact served and what constitutes "acceptability" and "efficiency" in this context. Some authors would object to my characterization of technology as serving human needs and purposes which shape its development. Ellul and Winner, for example, have proposed that technology too has become autonomous, principally governed by the internal norms of efficiency and expansion, to the detriment of other important human values and interests.) In turn, technological activities, especially those of engineering and mass industrial production, affect our environment, our perceived needs and desires and the way in which we work, live and play. Technology has such a pervasive influence on our lives that it conditions the way we experience the world, alters our values, and shapes the way we interact with one another.

In recent decades, a diverse group of thinkers has been severely critical of the role of technology in modern society. Their critiques have stemmed from a wide variety of concerns (e.g., aesthetic, ethical, theological, political, ecological) which are "humanistic" in the broadest sense of that all-purpose term. We shall try to sort out the different kinds of criticism expressed and see what reasons and arguments are offered in their support. We shall also consider the case made by defenders of science and technology in the face of this attack. Our study will include an examination of how technology and society have interacted in the past and how technology might shape society in the future, both in general terms and with regard to the energy question.

Organization: The course is organized around the following six topics:

1. Introduction: The Nature of Science and Technology.

2. The Critique of Science and Technology in the '60s and '70s.

3. Visions of the Future: Utopia or Dystopia?

4. Some Recent Defenders of Science and Technology.

5. Technology in Historical and Cultural Perspective.

6. Technology and the Energy Question.

Required Books:

Albert H. Teich (ed.), Technology and Man's Future. 3rd ed. NY: St. Martin's Press, 1981.
Lewis Mumford, Technics and Civilization. 1934. Reprint ed. NY: Harcourt, Brace & World, 1963.
Aldous Huxley, Brave New World, and Brave New World Revisited. NY: Harper & Row, 1965.
B. F. Skinner, Walden Two. NY: Macmillan, 1948. The 1976 reprint was used, which includes Skinner's, "Walden Two Revisited."
Barry Commoner, The Poverty of Power: Energy and the Economic Crisis. NY: Alred A. Knopf, 1976.
Samuel Florman, The Existential Pleasures of Engineering. NY: St. Martin's Press, 1975.

Bernard Gendron, *Technology and the Human Condition*. NY: St. Martin's Press, 1977.

All these books are available in relatively inexpensive paperback editions.

Books and Articles Available on Reserve:

S. Florman, *Blaming Technology*. St. Martin's Press, NY, 1981.
Barry Commoner, *The Closing Circle: Nature, Man and Technology*. NY: Alfred A. Knopf, 1972.
Barry Commoner, *The Politics of Energy*. NY: Alfred A. Knopf, 1979.
G. Foley, *The Energy Question*. NY: Penguin Books, 1976.
J. Passmore, *Science and Its Critics*. New Brunswick, NJ: Rutgers Univ. Press, 1978.
J. Passmore, *Man's Responsibility for Nature: Ecological Problems and Western Traditions*. NY: Charles Scribner & Sons, 1974.
D. de Solla Price, *Science Since Babylon*. New Haven, CN: Yale Univ. Press, 1961.
J. Bernstein, *Hans Bethe: The Prophet of Energy*. NY: Basic Books, 1980.
Jean Gimpel, *The Medieval Machine: The Industrial Revolution of the Middle Ages*. NY: Holt, Rinehart & Winston, 1976.
Kathleen Kinkade, *A Walden Two Experiment: The First Five Years of Twin Oaks Community*. NY: William Morrow, 1972.
B. F. Skinner, *Beyond Freedom and Dignity*. NY: Alred A. Knopf, 1971.
Langdon Winner, *Autonomous Technology: Technics Out of Control as a Theme in Political Thought*. Cambridge, MA: MIT Press, 1977.
A. MacIntyre, *Herbert Marcuse: An Expositon and a Polemic*. NY: Viking Press, 1970.
K. Lorenz, *On Aggression*. NY: Harcourt, Brace & World, 1966.
Herbert Marcuse, *One-Dimensional Man*. Boston: Beacon Press, 1964.
Jacques Ellul, *The Technological Society*. Trans. ed. NY: Alfred A. Knopf, 1964.
Lynn White, Jr., *Medieval Technology and Social Change*. Oxford: Clarendon Press, 1962.
John Maddox, *The Doomsday Syndrome*. NY: McGraw-Hill, 1972.
Donella H. Meadows, et al, *The Limits to Growth*. 1972 2nd ed. NY: Universe Books, 1974.
Mihaljo Mesarovic and Edward Pestel, *Mankind at the Turning Point*. NY: E. P. Dutton, 1974.
L. White, Jr., "The Historical Roots of Our Ecologic Crisis," *Science* 155 (10 March 1967): 1203-7.
N. Rescher, "The Environmental Crisis and the Quality of Life," in W. T. Blackstone, ed., *Philosphy and the Environmental Crisis*. Athens, GA: Univ. of Georgia Press, 1974, pp. 90-104.
N. Chomsky, "Beyond Freedom and Dignity," *New York Review of Books* 17 (30 December 1971): 18-24.
J. R. Platt, "The Skinnerian Revolution," in H. Wheeler, ed., *Beyond the Punitive Society*. San Francisco: W. H. Freeman & Co., 1973, pp. 22-56.
P. S. Greenspan, "Behavior Control and Freedom of Action," *The Philosophical Review* 87 (April 1978): 225-40.
W. Gaylin, "Skinner Redux," *Harper's Magazine* 247 (October 1973): 48-56.
E. Nagel, "Malicious Philosophies of Science," *Partisan Review* 10 (1943) reprinted in E. Nagel, *Sovereign Reason And Other Studies*

in the Philosophy of Science. Glencoe, IL: Free Press, 1954, pp. 17-35.

L. Mumford, "The Pentagon of Power," *Horizon* 12 (Autumn 1970): 4-21.

R. A. Hinde, "The Nature of Aggression (no reference I'm afraid-- Hinde is Royal Society Research Professor, University of Cambridge, Fellow of St. John's College, Cambridge).

S. A. Barnett, "On the Hazards of Analogies," *Scientific American* 216 (February 1967): 135-38.

A. Weinberg, "Social Institutions and Nuclear Energy," *Science* 177 (7 July 1972): 27-34. See also "Letters" for 1 December 1972.

L. Winner, "On Criticizing Technology," *Public Policy* 20 (Winter 1972): 35-59.

'Daedalus of New Scientist', "Pure Technology," *Technology Review* 72 (June 1970): 38-45.

S. Weinberg, "Reflections of a Working Scientist," *Daedalus* 103 (Summer 1974): 33-46.

P. Feyerabend, "How to Defend Society Against Science," *Radical Philosophy* 11 (1975): 3-8.

L. Marx, "Reflections on the Neo-Romantic Critique of Science," *Daedalus* 107 (Spring 1978): 61-74.

Evaluation: A course of this kind is clearly unsuited to evaluation by means of examination. Consequently your grade will be determined by two factors: (A) Contributions to class discussion; (B) Performance in four papers written throughout the term. These papers should be typewritten, double-spaced and between 5 and 10 pages in length. Their length is not of paramount importance, but their quality is. Deadlines for each paper will be set and rigidly adhered to. You will have the opportunity to rewrite your first two papers once, if you so desire. The grade for each of the papers will depend on both their style and their content. They should be written in clear, grammatical English and deal with substantive issues raised during the course. You should adopt a definite point of view and argue for it clearly and effectively. Lists of suggested paper topics will be distributed along with a selective bibliography to aid in your research.

Lectures

1. Introduction to Course.

2. What is the Difference Between Science and Technology?
   *Price, *Science Since Babylon*, Ch. 6.

3. The Critique of Science and Technology in the '60s and '70s.
   An Overview. Florman, Chs. 1-4. Teich, pp. 335-54 and 369-85. *Winner, "On Criticizing Technology."

4. Political and Moral Criticisms.
   Teich, pp. 40-62. *Winner, *Autonomous Technology*. *Marcuse, *One-Dimensional Man*, Ch. 1.

5. Political and Moral Criticisms.
   Teich, pp. 130-63. Gendron, Ch. 9.

6. Environmental and Ecological Criticisms.
   *B. Commoner, *The Closing Circle*. Gendron, Ch. 10.

7. Environmental and Ecological Criticisms.
    *White, "The Historical Roots of Our Ecologic Crisis."
    *Rescher, "The Environmental Crisis and the Quality of Life."

8. Anti-Reductionism. *Mumford, "The Pentagon of Power."

9. Sexual Alienation. Gendron, Ch. 7.

10. Worker Alienation. Gendron, Ch. 8.

11. Film. F. Lang, Metropolis.

12. Film. C. Chaplin, Modern Times.

13. Survey of Utopian and Dystopian Literature.

14. Brave New World. Huxley, Chs. 1-7.

15. Brave New World. Huxley, Chs. 8-18.

16. Huxley's "Brave New World Revisited."

17. Walden II, Chs. 1-12.

18. Walden II, Chs. 13-24.

19. Walden II, Chs. 25-36.

20. Skinner and His critics.
    *Chomsky, "Beyond Freedom and Dignity." *Gaylin, "Skinner Redux." *Skinner, Beyond Freedom and Dignity.

21. Freedom and Control.
    Gendron, Ch. 6. *Greenspan, "Behavior Control and Freedom of Action."

22. Florman's Critique of Antitechnology. Florman, Chs. 5 and 6.

23. Florman's "Existential" Philosophy of Engineering. Florman, Chs. 6-11.

24. The Social Value of Technology. Teich, pp. 29-39.
    *Daedalus of New Scientist, "Pure Technology."

25. The Defense of Science.
    Weinberg, "Reflections of a Working Scientist."
    *Feyerabend, "How to Defend Society Against Science."

26. Scientific Explanation and Positivism.
    *Passmore, Science and Its Critics, Ch. 1.
    *Nagel, "Malicious Philosophies of Science."

27. Passmore's Defense of Science and Technology.
    *Passmore, Science and Its Critics, Chs. 2 and 3.

28. Mumford's Approach to the History of Technology.
    Mumford, Introduction and Ch. 1.

29. Science and Technology in the Ancient World.
    *Price, _Science Since Babylon_, Chs. 1-3.

30. Technology in the Middle Ages. Mumford, Ch. 3.

31. Technology in the Middle Ages. *Gimpel, _The Medieval Machine_.

32. The Industrial Revolution. Mumford, Ch. 4.

33. Film. K. Clark, _Heroic Materialism_.

34. Film. J. Bronowski, _The Drive For Power_.

35. Mumford on the Neotechnic Era. Mumford, Ch. 5.

36. The Post-Industrial Revolution and the Utopian Argument.
    Gendron, Chs. 1-4.

37. Scarcity and Aggression.
    *K. Lorenz, _On Aggression_.
    *S. A. Barnett, "On the Hazards of Analogies."
    *R. A. Hinde, "The Nature of Aggression."

38. The Energy Question in Scientific and Historical Perspective.
    Commoner, Chs. 1 and 2. *Foley, _The Energy Question_,
    Part I.

39. Coal. Commoner, Ch. 4, *Foley, Ch. 7.

40. Oil and Gas.
    Commoner, Ch. 3. *Foley, Chs. 8 and 9.

41. Nuclear Power.
    Commoner, Ch. 5. *Foley, Ch. 10.
    *Weinberg, "Social Institutions and Nuclear Energy."

42. Solar Energy.
    Commoner, Ch. 6. *Commoner, _The Politics of Energy_.
    *Foley, Ch. 11.

43. Planning for Scarcity: The Elimination of Waste.
    Commoner, Chs. 7 and 9. *Foley, Part III.

44. The Hazards of Futurology.
    Teich, pp. 190-228. *Meadows, _The Limits to Growth_.
    *Mesarovic, _Mankind at the Turning Point_.
    *Maddox, _The Doomsday Syndrome_.

*Indicates on reserve.

Note: The average semester at Purdue consists of 44 one-hour class periods. We follow the topics in the order indicated but do not always devote exactly one hour to each. Some receive more attention, some less. Of the four films shown, "Heroic Materialism" is in Kenneth Clark's _Civilisation_ series and "The Drive to Power" is in Jacob Bronowski's series, _The Ascent of Man_. These along with _Metropolis_ are in our Audio-Visual Library. _Modern Times_ is rather expensive to rent.

Sample of Suggested Essay Topics

1. Is there a difference between science and technology? If so, where do you think the most important differences lie? What is the relationship between them? (In your discussion you might try to formulate satisfactory definitions of "science" and "technology.")

2. What do the modern anti-reductionist critics of science and technology (e.g. Mumford and Roszak) mean by the term "anti-reductionism"? How reasonable do you find their criticisms?

3. What specific political threats to man's freedom do critics such as Ellul, Marcuse and McDermott find in modern technological society? How well-founded do you think these fears are?

4. Do you take the article "Pure Technology" seriously?

5. How successful is Florman's own attempt at founding an "existential" philosophy of engineering in meeting the objections of the anti-technologists?

6. Do you agree with Gendron that "there . . . appears to be something incoherent in the Countercultural Dystopian perspective" (*Technology and the Human Condition*, p. 133) when the plea is made for sexual liberation?

7. On what grounds does Gendron reject the Utopian view? Do you agree with his analysis?

8. Do you think that Huxley's *Brave New World* paints an accurate picture of the kind of society we might inhabit if present trends continue? (In your essay, pay particular attention to Huxley's own reflections on this question in his *Brave New World Revisited*. You may wish to restrict your attention to just a few of the features which Huxley discusses.)

9. How would you defend Skinner against the charge that the society described in *Walden II* is destructive of human freedom?

10. What do *you* think is wrong with Walden II?

11. Do you think Konrad Lorenz's *On Aggression* should be taken seriously by Utopian theorists and their Dystopian critics?

12. What do positivists mean when they say that science does not explain but (merely) describes?

13. What is operationalism? (You may wish to consider P. W. Bridgman, *The Logic of Modern Physics* and C. G. Hempel, "A Logical Appraisal of Operationism" in C. G. Hempel, *Aspects of Scientific Explanation*.)

14. What is a machine? Try to refine your definition by considering a wide range of examples. According to your definition, which, if any, of the following are machines: a computer, the human brain, the human body, society as a whole (or some organized part of society)?

15. Compare and contrast the interpretations of the Industrial Revolution (the paleotechnic era) given by Mumford, Clark and Bronowski.

16. "The notion that a handful of British inventors suddenly made the wheels hum in the 18th century is too crude even to dish up as a fairy tale to children" (Mumford, *Technics and Civilization*, p. 106). In what ways does Mumford argue that the Eotechnic era "prepared the way" for the industrial revolution of the 18th and 19th centuries?

17. Compare and contrast Mumford and Gimpel on the role of technology in the Middle Ages.

18. In what important respects does the Neotechnic era differ from the Paleotechnic era for Mumford and form a basis for his cautious optimism about the future in *Technics and Civilizaion*?

19. Critically evaluate Commoner's advocacy of solar power as a crucial source of energy in the future.

20. Are the current fears about the dangers of nuclear power over-exaggerated?

21. How justified are the criticisms of *The Limits to Growth* offered by Christopher Freeman in "Malthus with a Computer" (*Technology and Man's Future*)?

TECHNOLOGY AND HUMAN VALUES

Steven L. Goldman

STS Program
Lehigh University
Bethlehem, PA

Required Books:

- Samuel Florman, The Existential Pleasures of Engineering (NY: St. Martin's Press, 1976).
- Hayrettin Kardestuncer, ed., Social Consequences of Engineering (San Francisco: Boyd and Fraser, 1979).
- B.F. Skinner, Beyond Freedom and Dignity (NY: Alfred A. Knopf, 1971).
- Richard C. Dorf and Yvonne L. Hunter, eds., Appropriate Visions: Technology, The Environment, and the Individual (San Francisco: Boyd and Fraser, 1978).
- Daniel Boorstin, The Republic of Technology: Reflections on Our Future Community (NY: Harper and Row, 1978).

Course Outline:

Week 1: Introduction to the notion that technology has become problematic for society and has been perceived as such since the 1960s.

Final Connections: Technology and Change episode evoking discussion of the following issues: technological change and the social and psychological problems it poses; artifacts as networks enmeshing us and implicating the whole social fabric in our personal lives; prediction as a means of potentially anticipating technology-generated social changes; social postures for controlling technology's impact/influence on society.

Florman, Existential Pleasure of Engineering, chap 1 and Kardestuncer, Social Consequences of Engineering, chap 1. The engineer's social role and public image. What does an engineer do and how does it get done?

Distinguish between "engineering" and "technology," the latter a social process at the heart of which lies the technical problem-solving activity called "engineering."

Week 2: Florman, Existential Pleasures, chapters 2 and 3

The rise of popular anti-technology in the '60s. The major anti-technology positions: are they critical of technology or of engineering? Distinguish between facts and values, between subjectivity and objectivity. Is the world large enough for facts and values? Florman's defense of engineering: does it successfully transfer primary responsibility to entrepreneurs and politicians for the social problems traceable to technology? Does it allay fears (as in Vonnegut's Player Piano and in Werner von Braun's life's work) of unlimited technical cleverness as a social threat uniquely posed by an engineering profession that floats free of its social context? Does it succeed in revealing engineering as an activity as essentially human as art, philosophy, politics, and religion?

Weeks 3 - 7: Kardestuncer, *Social Consequences of Engineering*, chapters 2-7, 10

The response of the engineer to major societal problems:

- Habitat
- Energy
- Transportation
- Communications
- Information
- Pollution
- Risk-Benefit Assessment

What are the elements of an engineering response to a societal problem: define the problem; model the problem; generate predictions from the model; devise a policy based on the model; implement the policy. At what level do personal and social values enter into the response? How are technology assessment, social impact assessment, environmental impact statements to fit into that response?

How does the technical response of the engineer compare/contrast with political and moral responses to the need to solve these social problems?

How are judgments incorporating social values to become incorporated into engineering, or should they be excluded? What are the moral and professional responsibilities of engineers for the social impact of their work? What are the moral obligations of society for the technologies it chooses to use?

Weeks 8 - 9: Skinner, *Beyond Freedom and Dignity*

Skinner presents a detailed argument on behalf of a totalitarian engineering approach to individual behavior as a route to resolving societal problems. The fact-value distinction is here treated boldly, inescapably, and controversially. Does Skinner succeed in converting a classical moral approach to problem-solving into an engineering approach? As everyone's behavior is universally acknowledged to be controlled to some degree by physical, social, and cultural factors, what makes Skinner's program controversial? Does behavioral technnology avoid the classic "schizophrenic" split between possessing a technique and choosing to use it?

Weeks 10 - 12: Dorf and Hunter, Editors, *Appropriate Visions*

The ecology and intermediate technology movements: attempts at bringing *selected* values into engineering and at introducing a measure of deliberate social control over technology. The ethical and spiritual bases of intermediate technology. *Is* small beautiful? Intermediate technology, energy, and the "Third World". Can *we* help *them*? Is appropriate technology different from good engineering? *Can* engineering become the arm of an ideology without coming into open conflict with the established social process of technology?

Week 13: Conclusion: Boorstin, *The Republic of Technology*

A reasoned appreciation of technology as a driving force behind modern social progress in the West. How has the impact of technological innovation on society differed from the impact of political "innovations"? Is the Republic of (Modern) Technology intrinsically democratic or only apparently so? Given the role that vested interests, new or existing, must play in such innovation, can the public *not* be manipulated by them? What price do we pay as a society for modern technology and how could we go about deciding if the benefits are worth the cost?

VALUES AND ETHICS IN SCIENCE AND TECHNOLOGY

Carl Barus and Patricia Springborg

Department of Engineering, Department of Philosophy
Swarthmore College
Swarthmore, PA

Values and Ethics in Science and Technology deals with topics such as the following: historical and current attitudes toward technology; the nature of ethics; origins and impact of professional ethics (chiefly in the engineering professions); ethical dilemmas faced by engineers and scientists; values in the technological society; forecasting and assessment of technological growth; how policy decisions about technology are made; the role of personal ethics of the engineer or scientist. Open to all who have completed the science distribution requirement.

Textbooks:

Burke, J. G. & Eakin, M. C., eds., Technology and Change (San Francisco: Boyd and Fraser, 1979).
Flores, A. & Baum, R., eds., Ethical Problems in Engineering, 2nd ed. (2 volumes), (Troy, NY: Center for Study of Human Dimensions in Science and Technology, RPI, 1980).
Other readings on library reserve. (Publishing information listed with first citation only.)

WEEK 1: Introductory Topics - Scientists' ethical dilemmas (bombs and other worries) - the DC-10 case.

Reading:

Burke & Eakin, concerning nuclear weapons (Einstein, Oppenheimer, Sakharov).
Baum, concerning the DC-10.

Recommended:

U. S. Atomic Energy Commission - In the Matter of J. Robert Oppenheimer (Washington: U. S. Govt. Printing Office, 1954).
Kipphardt, H. In the Matter of J. Robert Oppenheimer, (dramatization of the AEC Hearings) (NY: Hill and Wang, 1968).
Curtis, Charles P. The Oppenheimer Case: The Trial of a Security System (NY: Simon and Schuster, 1955).

WEEK 2: Historical Attitudes Toward Science and Technology -- The socialization of nature: technology and culture -- Historical protests against technological development.

Reading:

Burke & Eakin: historical papers by Drucker, Ashton, Bronowski, Cipolla, L. White, R. Heilbroner.
White, Lynn, Jr., "The Historical Roots of our Ecologic Crisis"

Science 155 (10 March 1967): 1203-7. Also in Carl Mitcham and Robert Mackey, eds. *Philosophy and Technology* (Glencoe, IL: Free Press, 1972).

Recommended:

Engels, Frederick, *Anti-Dühring* (Moscow, Progress Publishers, 1969).

WEEK 3: Ethics, Choice and Responsibility and Their Relation to Technology - Moral choice and responsibility - Technology and human requirements - Alienation and technology.

Student papers: Can knowledge be bad? Limits of technological solutions.

Reading:

Aristotle, *Nicomachean Ethics*, Book II, Book III, Chs. 1-5 (NY: Penguin, 1962).
Marx/Engels Reader, Robert C. Tucker, ed. 2nd ed. (NY: Norton, 1978), pp. 66-105. (1844 Manuscripts: Estranged Labour - Private Property and Communism - The Meaning of Human Requirements The Power of Money).

Recommended:

Mumford, Lewis, "Technics and the Nature of Man," in Mitcham and Mackey.
Simon, Yves R., "Pursuit of Happiness and Lust for Power in Technological Society," in Mitcham and Mackey.

WEEK 4: Needs and Progress - The concept of needs - The role of needs as the motor of progress - Can true and false needs be posited?

Student papers: Three on technology and human needs.

Reading:

Marx/Engels Reader, pp. 71-109 (Economic and Philosophic Manuscripts of 1844).
Marx/Engels Reader, pp. 148-200 (The German Ideology).

Recommended:

Macpherson, C. B., "Needs and Wants: An Ontological or Historical Problem? in R. Fitzgerald, ed. *Human Needs and Politics* (Elmsford, NY: Pergamon Press, 1977).
Neilsen, Kai, "True Needs, Rationality and Emancipation," in Fitzgerald, ed., *Human Needs and Politics*.
Marcuse, Herbert, *One Dimensional Man* (Boston: Beacon Press, 1964).
Heller, Agnes, "Can 'True' and 'False' Needs be Posited?" in

Katrin Lederer & Johan Galtung, eds., *Human Needs: A Contribution to the Current Debate* (Cambridge, MA: Oelgeschlager, 1980).

WEEK 5: Professional Ethics and Professional Societies - Origins of professional engineering societies and professional ethics in the U.S. - Ideology of professionalism - Some professional codes.

Student papers: Justification of needs; Proliferation of Needs; New Luddites.

Reading:

Flores, et al., Chapter I: Introduction; papers by Mead, Wisely, Cebik, Kultgen, Baum; Codes.
Burke & Eakin: papers by Fairbairn and Veblen.
Kline, R. R., "Professionalism and the Corporate Engineer: Charles P. Steinmetz and the AIEE," *IEEE Trans. on Education* E-23 (Aug. 1980): 144-50.

Recommended:

Steinmetz, Charles P., *America and the New Epoch* (NY: Harper & Bros., 1916).
Layton, E. T., *The Revolt of the Engineers* (Cleveland, OH: Case Western Reserve Press, 1971).
Kevles, D. J., et al., "The Sciences in America, circa 1880," *Science* 209 (4 July 1980): 27-32.
Hounshell, D. A., "Edison and the Pure Science Ideal in 19th Century America," *Science* 207 (8 February 1980): 612-17.

WEEK 6: Employers, Ethics, and Professional Employees - Criticism of professional codes of ethics; role of professional societies - "Industrial exemption" -- loyalty to industrial employer vs. loyalty to profession - Ethical dilemmas of the employed professional - "Whistle blowing."

Student papers: National Academy of Sciences; Ethics of military work; Engineering ethics in the early 20th century.

Reading:

Burke & Eakin: paper by Marlow.
Flores: papers by Salvadori, Unger, Robbi, Pavlovic, Florman, Fruchtbaum, Tate, Flores, Martin, Otten, and "Guidelines."

Recommended:

Westin, Alan F., *Whistle Blowing: Loyalty and Dissent in the Corporation* (NY: McGraw-Hill, 1980).

WEEK 7: Ethical Heroes, Villains and Victims - "Whistle blowing" (continued) - Data falsification and plagiarism - Case studies - Role of professional societies in support of ethical professionals.

Reading:

Flores: paper by Layton.
Baum: Hooker memos; Cravey, Edgerton and BART cases, Houston, Goodyear brake, Pinto, DC-10 revisited, Tate.
Chalk, Rosemary and Von Hippel, F., "Due Process for Dissenting 'Whistle-Blowers'," Technology Review 81 (June/July, 1979): 48-55.
Broad, William J., "Imbroglio at Yale: Emergence of a Fraud," Science 210 (3 Oct. 1980): 38-41 et seq.

Recommended:

Dorfman, D. D., The Cyril Burt Question, Science 201 (29 Sept. 1978): 1177-86.
Anderson, R. M., et al., Divided Loyalties: Whistle-Blowing at BART (West Lafayette, IN: Purdue Univ. Press, 1980).
DeGeorge, R. T., "Ethical Responsibilities of Engineers in Large Organizations: The Pinto case," Conference on Engineering Ethics, RPI, June 1980.

WEEK 8: Values in Pure Science and Applied Science - Is science value-free? Guest Lecturer: Prof. Richard Schuldenfrei.

Reading:

Hempel, C. G., "Science and Human Values" in Aspects of Scientific Explanation (Glencoe, IL: Free Press, 1970).
Weber, Max, "Science as a Vocation" in Hans Gerth and C. Wright Mills, eds. From Wax Weber (NY: Oxford Univ. Press, 1946).
Weber, Max, The Protestant Ethic and the Spirit of Capitalism, rev. ed. (NY, Scribner's, 1977), Chapter III, part A, and Chapter V.

WEEK 9: The Technological Society - Is technology autonomous, self-propelling? - Is technology designed to meet human needs?

Reading:

Burke & Eakin: papers by Mumford and Ellul (longer version of Ellul's paper in Mitcham & Mackey).
Winner, Langdon, Autonomous Technology (Cambridge, MA: MIT, 1977), Chapter 1 and "Frankenstein's Problem," pp. 306-17.
McDermott, J., "Technology: The Opiate of the Intellectuals," in A. H. Teich, ed., Technology and Man's Future 1972, 3rd ed. (NY: St. Martins Press, 1981), (see also preceding paper in Teich, Emmanuel G. Mesthene "The Role of Technology in Society."

Leiss, W., The Limits to Satisfaction (Toronto: Univ. of Toronto Press, 1976).
Springborg, P., Critique of Leiss in The Problem of Human Needs and the Critique of Civilization (Winchester, MA: Allen Unwin, 1981).

Recommended:

Ellul, J., The Technological Society 1954 (NY: Knopf- Vintage, 1964).
Mumford, L., The Myth of the Machine 2 vols. (NY: Harcourt, Brace & Jovanovitch, 1967, 1970).

WEEK 10: The Technological Imperative - Does technology create freedom of individual choice? Do values set the course of technology? Is technology a neutral set of tools? Is it means or end? Guest: Professor Hugh Lacey.

Student papers; Social Darwinism; Technology and the Protestant Ethic.

Reading:

Habermas, J., "Ideology and Technology" in Toward a Rational Society (Boston, MA: Beacon Press, 1971).
Heidegger, M., The Question Concerning Technology and Other Essays (NY: Harper & Row, 1977).
Balabanian, N., "On the Neutrality of Technology" (MS). Also "Technology, Freedom, and Individual Autonomy," STS Newsletter, No. 15 (Dec. 1979): 1-4.
Flores: paper by Stever.
Burke & Eakin: paper by Florman.

Recommended:

Lipscombe, J. and Williams, B., Are Science and Technology Neutral? (London: Butterworths, 1979).
Dickson, D., The Politics of Alternative Technology (NY: University Books, 1975), Chapter 2, "The Ideology of Industrialization"; Chapter 3, "The Politics of Technical Change."
Florman, S., The Existential Pleasures of Engineering (NY: St. Martin's Press, 1976).

WEEK 11: Technological Policy - Policy making and public participation - Technology assessment.

Student papers: Solar power satellite and public participation; Technology and policy; Systems theory applied to social problems.

Reading:

Flores: paper by Tribus.

Burke & Eakin: papers by Drucker, Winner, Nelkin and Brooks.
Kantrowitz, A., "Controlling Engineering Democratically," in Hayrettin Kardestuncer, ed. *Social Consequences of Engineering* (San Francisco: Boyd and Fraser, 1979), pp. 271-84.
Taylor, Vince, "Subjectivity and Science," *Technology Review* (Feb. 1979): 49-57.
Schrader-Frechette, Kristin, "Technology Assessment as Applied Philosophy of Science," *Science, Technology and Human Values* 33 (Fall 1980): 33-50.

Recommended:

Nelkin, D., "Technology and Public Policy," in Ina Spiegel- Rosing and Derek deSolla Price, eds., *Science, Technology and Society* (Beverly Hills, CA: Sage, 1977), pp. 393-441.
Braun, E., et al., *Assessment of Technical Decisions: Case Studies* (London: Butterworths, 1979).
Coates, V. T. and Finn, B., *A Retrospective Technology Assessment: Submarine Telegraphy; The Transatlantic Cable of 1866* (San Francisco: San Francisco Press, 1979).

WEEK 12: Rational Decision Making - System analysis - Risk analysis - Cost-Benefit analysis.

Student papers: Planned obsolescence; On acceptable risk.

Reading:

Flores: paper by Wildavsky.
Burke & Eakin: paper by Ramo.
Roszak, T., *Where the Wasteland Ends* (Garden City, NY: Doubleday, 1972), pp. 28-73.
Berlinski, D., *On Systems Analysis* (Cambridge, MA: MIT Press, 1977), Chapter 1.
Lowrance, W., *Of Acceptable Risk* (Los Altos, CA: Kaufmann, 1976), Chapter 4 and pp. 94-95.
Baram, M., "Cost-Benefit Analysis," *Ecology Law Quarterly* 8 (1980): 473-531, Sections I and II.
Hoos, Ida, *Systems Analysis in Public Policy: A Critique* (Berkeley, CA: Univ. of Calif. Press, 1973), Chapter 2.

WEEK 13: Technology and Power - Computers and information - Centralized vs. distributed technology - Technological development of the Third World.

Student papers: Data processing and implications; Appropriate technology and the Third World.

Reading:

Burke & Eakin: papers by Mumford, Ramo, Jensen, Zaheer, and Clark.
Mowshowitz, A., *The Conquest of Will* (Reading, MA: Addison Wesley, 1976), Chapter 12.
Weizenbaum, J., *Computer Power and Human Reason* (San Francisco: W. H. Freeman, 1976), Chapter 10.

Dickson, D., The Politics of Alternative Technology (NY: Universe Books, 1975), Chapter 6.
Lappe, Francis M. and Collins, J., Food First: Beyond the Myth of Scarcity (Boston: Houghton-Mifflin, 1977), Part IV - "Modernizing Hunger."

Recommended:

Dickson, Chapter 2 - "The Ideology of Industrialization," (see above)
Mowshowitz and Weizenbaum - further optional browsing (see above).
Boyle, G., et al., The Politics of Technology (NY: Longman, 1977), Section 4 - "Decentralization and Community Technology."
Long, F. A. & Oleson, eds., Appropriate Technology and Social Values (Cambridge, MA: Ballinger, 1980).
Sadar & Rosser-Owen, "Science Policy and Developing Countries," in Spiegel-Rosing & Price, pp. 535-75.
Brown, L., "Food vs. Fuel," Environment 22 (May 1980): 33-41.

WEEK 14: Personal Responsibility; Secret Research - Personal responsibility of the scientist/engineer - Secret and military research in the university or college.

Student papers: Personal ethics and weapons; Personal responsibility; Personal dilemmas in nuclear technology.

Reading:

Flores: papers by Ladenson and Collins. Baum: paper by Shapley. Burke and Eakin: paper by Wright.
Smith, J. E., "Science and Conscience," American Scientist 68 (Sept./Oct. 1980): 554-58.
Glantz and Albers, "Department of Defense R&D in the University," Science 186 (22 Nov. 1974): 706-11.
Rivello, J. Roberta, "Engineering Ethics and Military Design," Conference on Engineering Ethics, RPI, June 1980.
Brownowski, J., "The Disestablishment of Science," N. Y. Times (18-19 Oct. 1971), op. ed..
Papers concerning chemical and biological warfare research at University of Pennsylvania.
Teller, E., "Kicking the Secrecy Habit," N. Y. Times (27 May 1973) op. ed.

Recommended:

Snow, C. P., Science and Government (Cambridge, MA: Harvard, 1961).

SCIENCE, TECHNOLOGY, AND PUBLIC POLICY

Lynton K. Caldwell and Robert V. Bartlett

Dept. of Political Science
and School of Public & Environmental Affairs
Indiana University
Bloomington, IN

This course will cover historical relationships between government, science, and technology; organization for science policy in major governments; and political, administrative, and technical procedures through which public policy on science and technology is formulated. International programs for science and technology will be considered, and principal policy issues will be identified.

This course has two major purposes. The first is to foster student awareness of the significance of science and technology as social forces in modern societies, and to develop understanding of the crucial relationships between science, technology, and government. The second major purpose is to provide an overview and introduction to science, technology, and public policy as a field of study, for those students wishing to undertake further work in this area. Consequently, it will be necessary to cover a wide range of topics with a high degree of generality. Obviously, each of the topics outlined in this syllabus could easily be the subject of a full semester graduate-level course by itself; nevertheless, our purposes are better served by a greater comprehensiveness of scope.

This course is organized as a seminar, with the entire course grade to be determined by the quality of short weekly papers and class discussion. Weekly papers on assigned topics should be approximately three pages in length. A course paper on a subject of the student's choosing *may* be substituted for three of the weekly papers *at the student's option*. This paper need not be longer than ten to twelve pages and is due no later than Session 13.

It should be noted that this course is being offered on the assumption that the primary goal of every student enrolling is to learn. Consequently, we fully expect students to have read each week's material before coming to class, to complete writing tasks on time, and to play an active role in the learning process by participating in classroom discussion. Part of the course grade will depend on whether or not students live up to these obligations. We have designed the grading system to encourage students to learn by doing: any paper submitted on time may be rewritten and resubmitted within two weeks of the original due date, with only the higher grade counting. In this way, students so interested may take advantage of insights provided by the instructors' comments, the class discussion, and further reflection.

Note: This course is a graduate level course that is also open to advanced undergraduates. It presumes that students have little prior background in political science, the natural sciences, or history and philosophy of science.

A recommended reference for this course is provided by the publication *Science, Technology, and Public Policy: A Guide to Advanced Study* by Lynton K. Caldwell and Toufiq A. Siddiqi (Bloomington: Indiana University, School of Public and Environmental Affairs, 1972). Each of the topics selected for consideration during this semester is outlined in the *Study Guide*. Unfortunately, this *Study Guide* is no longer available for purchase, but it may be consulted at the libraries.

The following written materials have been ordered through the bookstores and should be available for purchase. In addition to the readings, all students should plan to become regular viewers of two television programs on PBS: Nova and Connections: Technology and Change. These programs will be referred to regularly in class.

Required Books:

- Bartlett, Robert V., The Reserve Mining Controversy: Science, Technology, and Environmental Quality. With Introduction and Concluding Observations by Lynton K. Caldwell (Bloomington: Indiana University Press, 1980).
- Brecht, Bertolt, Galileo, Eric Bentley, ed. Translated from German by Charles Laughton (New York: Grove Press (Random House), 1966).
- "Modern Technology: Problem or Opportunity?" Special Issue. Daedalus: Journal of the American Academy of Arts and Sciences 109 (Winter 1980).
- Durrenmatt, Friedrich, The Physicists. Translated from German by James Kirkup (New York: Grove Press (Random House), 1964).
- Ellul, Jacques, The Technological Society (New York: Vintage Books (Random House), 1967).
- Kuhn, Thomas, The Structure of Scientific Revolutions Second Edition, Enlarged (Chicago: University of Chicago Press, 1970).
- Medvedev, Zhores A., Soviet Science (New York: W.W. Norton, 1978).
- Nelkin, Dorothy, ed., Controversy: Politics of Technical Decisions (Beverly Hills, CA: Sage Publications, 1979).
- Snow, Charles P., Two Cultures and a Second Look (An Expanded Version of the Two Cultures and the Scientific Revolution) (London: Cambridge University Press, 1964).
- Strunk, William, Jr., and E.B. White, The Elements of Style Third edition (New York: Macmillan Company, 1979).
- Watson, James D., The Double Helix: A Personal Account of the Discovery of the Structure of DNA (New York: New American Library (Mentor Books), 1968).
- Zinsser, William, On Writing Well: An Informal Guide to Writing Non-fiction Second edition (New York: Harper and Row, 1980).

Class Schedule of Readings and Paper Topics:

WEEK 1: INTRODUCTION

Prerequisites for the Course:
1. Zinsser.
2. Strunk and White.
3. Recommended: Richard Mitchell, Less Than Words can Say (Boston: Little, Brown and Co., 1979).

WEEK 2: SCIENCE, TECHNOLOGY AND PUBLIC POLICY: SOME ISSUES

1. Durrenmatt.
2. Brecht.

Respond to _one_ of the following questions in no more than four double-spaced typewritten pages:

- a. In what ways is Durrenmatt's play _The Physicists_ relevant to the study of science, technology, and public policy?
- b. In what ways is Brecht's play _Galileo_ relevant to the study of science, technology, and public policy?

WEEK 3: SCIENCE AS AN ASPECT OF MODERN CULTURE

1. Snow.
2. Steven Maynard-Moody, "The Fetal Research Dispute," in Nelkin.
3. Dorothy Nelkin, "Creation Versus Evolution: The California Controversy," in Nelkin.
4. Sheldon Krimsky, "Regulating Recombinant DNA Research," in Nelkin.

Please respond to _one_ of the following topics:

- a. What would be the key points you would make, taking into account the developments of the past fifteen years, if you were to write an essay entitled "The Two Cultures and a Third Look"?
- b. Science in the abstract has sometimes been described as anti-cultural. Why? How does this view of science relate to the "two cultures" controversy?

WEEK 4: SCIENTIFIC WORK IN TECHNOLOGICAL SOCIETIES: MOLECULAR BIOLOGY

1. Watson.
2. Recommended: Horace Freeland Judson, _The Eighth Day of Creation: The Makers of the Revolution in Biology_ (New York: Simon and Schuster, 1979).

Write on _one_ of the following:

- a. What kind of picture of the structure of science emerges from _The Double Helix_? (Consider such matters as formal organizations, communication, funding, rewards, social norms, etc.)
- b. Are there discernible elements in scientific work that tend to cause scientists to react in predictable ways to social issues? For example, are particular social attitudes, or viewpoints, associated with science or with particular sciences? Support your argument by reference to _The Double Helix_.

WEEK 5: SCIENTIFIC WORK IN TECHNOLOGICAL SOCIETIES: THE SOVIET UNION

1. "The Lysenko Affair," _Nova_, 1974 (Media Center, Undergraduate Library).
2. Medvedev.
3. Thane Gustafson, "Environmental Conflict in the USSR," in Nelkin.

WEEK 6: SCIENTIFIC WORK IN TECHNOLOGICAL SOCIETIES: WHAT IS SCIENCE?

1. Lynn White Jr., "The Ecology of Our Science," _Science 80_ 1 (November-December 1979): 72-76.

2. Kenneth E. Boulding, "Science: Our Common Heritage," Science 207 (22 February 1980): 831-36.
3. Recommended: Paul Diesing, Patterns of Discovery in the Social Sciences (New York: Aldine, 1971).

Based on the readings so far this semester, especially Medvedev, White, and Boulding, write on one of the following:

a. Who are the scientists? How should the term "scientist" be defined? What "tests" should be applied to distinguish scientists from non-scientists? Are any such "tests" generally accepted in modern society?
b. Why is science as a profession sometimes compared to a priesthood? Is the analogy in any sense valid? What are the distinctions usually drawn between scientific and technical education? Are these distinctions valid?

WEEK 7: SCIENTIFIC WORK IN TECHNOLOGICAL SOCIETIES: WHAT IS SCIENCE?

1. Kuhn.
2. Terence Ball, "From Paradigms to Research Programs: Toward a Post-Kuhnian Political Science," American Journal of Political Science 20 (February 1976): 151-77.
3. Recommended: Thomas Kuhn, The Essential Tension (Chicago: University of Chicago Press, 1979), especially pp. 266-339.
4. Recommended: Imre Lakatos and Alan Musgrave, eds., Criticism and the Growth of Knowledge (London: Cambridge University Press, 1974), especially pp. 91-196.

Write on one of the following:

a. Analyze and evaluate the phrase "the scientific method." What has this phrase traditionally meant, for what purposes has it typically been used, and how well does it stand up in light of what White, Boulding, Kuhn, and Ball have to say?
b. Based on Kuhn, Ball, and earlier readings, evaluate the validity of each of the following dichotomies that have been postulated over the years:
    a) Hard and soft science
    b) Basic and applied science
    c) Theoretical and experimental science
    d) True and pseudo science
    e) Normal and revolutionary science.

WEEK 8: CONNECTIONS BETWEEN SCIENCE AND TECHNOLOGY

1. W.O. Baker, "Science and Technology," in Daedalus.
2. David Landes, "The Creation of Knowledge and Technique: Today's Task and Yesterday's Experience," in Daedalus.

Is "advanced technology" synonymous with "applied science" or are there differences between these terms? If there are differences, what are their implications? Do you agree that interaction between science and technology is more the exception than the rule and that the achievements of the last two centuries owe more to the advance of technology than to the progress of science?

WEEK 9: THE SOCIAL IMPACT OF SCIENCE AND TECHNOLOGY

1. Ellul.

Write on one of the following:

a. Analyze the seven characteristics of modern technique that Ellul mentions. Assess Ellul's discussion of these characteristics. Do these characteristics add up to "technoscientific inevitability" in the modern world? What are the policy implications of these characteristics, if any?

b. What does Ellul mean by the following statement? Interpret, analyze, and evaluate each sentence as well as the passage as a whole. Support your position by referring to (not necessarily quoting) earlier arguments of Ellul in The Technological Society.

> "But what good is it to pose questions of motives? of Why? All that must be the work of some miserable intellectual who balks at technical progress. The attitude of the scientists, at any rate, is clear. Technique exists because it is technique. The golden age will be because it will be. Any other answer is superfluous."

c. Why have some observers pointed to the Soviet Union as the most advanced form of technological society? Is this a valid assessment? Why or why not? Compare the U.S.S.R. to the U.S.A. in this respect. Support your answer by referring to (not necessarily quoting) Ellul and Medvedev.

WEEK 10: THE SOCIAL IMPACT OF SCIENCE AND TECHNOLOGY

1. Ellul.

WEEK 11: POLICY PROBLEMS OF SCIENCE AND TECHNOLOGY

1. Dorothy Nelkin, "Science, Technology, and Political Conflict: Analyzing the Issues," in Nelkin.
2. Jerome Milch, "The Toronto Airport Controversy" in Nelkin.
3. Dorothy Nelkin, "Nuclear Power and its Critics: A Siting Dispute," in Nelkin.
4. Susan Fallows, "The Nuclear Waste Disposal Controversy," in Nelkin.
5. Susan G. Hadden, "DES and the Assessment of Risk," in Nelkin.
6. Michael Brown, "Setting Occupational Health Standards: The Vinyl Chloride Case," in Nelkin.

Using the readings in Nelkin's book as a source of ideas, examples, and illustrations, respond to the following questions:

If we postulate a situation in which "scientific truth" and "political truth" are in conflict in society, which truth should prevail? Or, to what extent should each truth prevail? In what respects are the assumptions of science and democracy mutually reinforcing? In what respects are they potentially antagonistic?

WEEK 12: POLICY PROBLEMS OF SCIENCE AND TECHNOLOGY

1. Bartlett.

Write on one of the following:

a. In what ways, and to what extent (if at all), are the books by Snow, Watson, Medvedev, Kuhn, and Ellul useful in understanding the Reserve Mining controversy? Are the case studies in the Nelkin book useful in understanding the Reserve Mining controversy?

b. How can the public interest be served on pressing issues in the face of contradictory and irreconcilable scientific evidence? Does the public interest imply a need for the surveillance and control of investigation, research, and allegation made in the name of science? If so, how should this supervision be provided? (By law? By the scientific community? Through a government administrative process?) Draw on The Reserve Mining Controversy and earlier readings in framing your response.

WEEK 13: REGULATION OF SCIENCE AND TECHNOLOGY

1. Judith Peppy, "The Automobile Airbag," in Nelkin.
2. James C. Peterson and Gerald E. Markle, "The Laetrile Controversy," in Nelkin.
3. Joshua Ira Schwartz, "Smallpox Immunization: Controversial Episodes," in Nelkin.
4. Deborah Shapley, "Arms Control as a Regulator of Military Technology," in Daedalus.
5. David K. Stout, "The Impact of Technology on Economic Growth in the 1980s," in Daedalus.

Using the readings in Bartlett, Nelkin, and Daedalus as sources of ideas, examples, and illustrations, respond to one of the following:

a. What policy and operational problems arise from the interrelationships among universities, industrial establishments, professional groups, and various government agencies in the public administration of science and technology? Are these relationships consistent with traditional concepts of governmental accountability and distinctions between public and private interests? Can the reconciliation of democratic with scientific and technological values be undertaken through the administrative process?

b. What new "rights" have been made feasible by science and technology? What traditional "rights" have been modified or impaired? What problems with "rights" emerge as a result of attempts to regulate science and technology?

c. Some writers have charged that there are alternative programs, such as a war on poverty or improvement of existing health facilities, that would not require any basic research for their implementation and would promise a better rate of return in social and economic goods than a public investment in scientific research and tecnological development. Evaluate this argument.

WEEK 14: SCIENCE, TECHNOLOGY, AND PUBLIC POLICY

1. Langdon Winner, "Do Artifacts Have Politics?" in Daedalus.
2. N. Bruce Hannay and Robert E. McGinn, "The Anatomy of Modern Technology: Prolegomenon to an Improved Public Policy for the Social Management of Technology," in Daedalus.
3. Harvey Brooks, "Technology, Evolution and Purpose," in Daedalus.

In less than one double-spaced typewritten page, develop two questions which would be suitable topics for four-page essays. The questions should require analysis, evaluation, and synthesis of the subject matter and readings for this course, particularly those assigned from Daedalus for this week.

WEEK 15: GOVERNING THE TECHNOSCIENTIFIC SUPERCULTURE

1. Elting Morison, "The Uncertain Relation," in Daedalus.
2. Daniel T. Spreng and Alvin M. Weinberg, "Time and Decentralization," in Daedalus.
3. Walter Rosenblith, "A Note on Engineering and the Other Professions," in Daedalus.

4. Edward E. David, Jr., "On the Dimensions of the Technology Controversy," in Daedalus.

Based on the essays in Daedalus, particularly Winner, David, and Hannay and McGinn, assess the "political qualities" of the technologies at issue in the readings by Peppy, Peterson and Markle, Schwartz, Shapley, and Bartlett.

WEEK 16: GOVERNING THE TECHNOSCIENTIFIC SUPERCULTURE

1. Robert S. Morison, "A Further Note on Visions," in Daedalus.
2. Symposium, "Some Issues of Technology," in Daedalus.

What is the significance or relevance of R. Morison's essay in Daedalus to the arguments presented in earlier readings such as Snow, Ellul, Medvedev, and Nelkin?

APPENDIX:
BRIEFLY ANNOTATED
ADDITIONAL COURSE MATERIAL

ADDITIONAL COURSE MATERIAL

AHL, ALWYNELLE S. HISCOE, H. B. Dept. of Natural Science Kedzie Laboratory Michigan State University East Lansing, MI 48824	BIOETHICAL ISSUES IN HUMAN REPRODUCTION A quarter-length course focusing on the social and ethical issues surrounding scientific and technological developments in the area of human reproduction. Includes interesting readings and extensive study/exam questions.
AMERICAN ASSO. of UNIVERSITY WOMEN 2401 Virginia Ave., N.W. Washington, D.C. 20037	TAKING HOLD OF TECHNOLOGY A self-paced study guide that focuses on understanding what technology is and its relationship with women's roles, with special sections focusing on energy, communications and information, appropriate technology, and modes of technology assessment. Available for $4 from the AAUW.
ASTON, RICHARD DRISCOLL, JEAN Engineering Dept. Wilkes College P. O. Box 111 Wilkes-Barre, PA 18766	AN INTRODUCTION TO ENGINEERING TO ENHANCE HISTORICAL AND SOCIAL PERSPECTIVES A narrative summary of the development of an introductory course for engineers on the history of engineering and the social impact of technology that focuses on the innovative process. Includes references for possible texts.
BERGER, MICHAEL L. St. Mary's College of Maryland St. Mary's City, MD 20686	TECHNOLOGY AND HUMAN BEHAVIOR An interdisciplinary special topics seminar focusing on technology's impact upon human behavior; topics include the physical, intellectual, psychological and social development of individuals and society; values issues; ethical issues surrounding health and the environment; and transportation and communication development.
BINFORD, HENRY C. SMITH, CARL Depts. of History and English College of Arts and Sciences Northwestern University Evanston, IL 60201	HUMANISTIC RESPONSES TO TECHNOLOGICAL CHANGE and HUMANISTIC RESPONSES TO TECHNOLOGICAL CHANGE: THE CULTURE OF WORK A two-quarter sequence, the first half of which focuses on changing perceptions of society in the 19th and early 20th centuries. The second half concentrates on the changing nature and perception of work during the same period.

BLEED, PETER Dept. of Anthropology University of Nebraska 121 Benton Hall Lincoln, NE 68588-0619	PRIMITIVE TECHNOLOGY An anthropology course that seeks "to show how anthropologists can use technology as a point of view for the investigation of culture and human behavior in general." Includes an extensive supplementary bibliography.
BLUMBERG, AVROM A. Dept. of Chemistry DePaul University Chicago, IL 60614	PROBLEMS IN A TECHNOLOGICAL SOCIETY: MODERN WARFARE AND ARMS CONTROL This one semester course utilizes the subject material not only because of its inherent interest and worth, but also to acquaint the student with broader questions of scientific methodology, its relationship to technology, and its social context.
CARROLL, P. THOMAS Rennselaer Polytechnic Inst. 315B West Hall Troy, NY 12181	TECHNOLOGY IN AMERICAN HISTORY A well-balanced, one-semester survey focusing on the broader social context of American technology. Includes useful sample essay and exam questions.
CASSIDY, DAVID C. Universitat Regensburg D-8400 Regensburg West Germany	SCIENCE AND TECHNOLOGY IN THE POST-WAR ERA An introduction to the development of science and technology in the Federal Republic of Germany since W.W.II. Problems of European policy coordination, the dilemmas of the scientist, and science policy in other countries and economic systems are included. Topics and most readings are in German.
CERUZZI, PAUL 211 Hardin Hall Clemson University Clemson, SC 29631	STUDIES IN THE HISTORY OF IDEAS: THE HISTORY OF THE COMPUTER The core of this course focuses on the period ca. 1935-50 and relates the development of the modern electronic digital computer to broader scientific, industrial, and economic trends. Includes a list of additional readings.
CHASZAR, EDWARD Political Science Dept. Indiana University of PA Indiana, PA 15701	SCIENCE/TECHNOLOGY AND PUBLIC POLICY This political science seminar analyzes the public policy-making process as it relates to science and technology questions on the state, national, and international levels. An in-depth research paper and class presentaion from each student are major components of the course.

DUPREE, A. HUNTER Dept. of History Brown University Providence, RI 02913	PERSPECTIVES IN TECHNOLOGY AND ENVIRONMENT An intriguing historical analysis of the interactions between technology and the environment, utilizing perspectives from other disciplines as well. Covers roughly the years of 1500-1850, setting the course theme within the context of the major technological developments of the period.
DUTCH, STEVEN College of Environmental Sciences Univ. of Wisconsin-Green Bay Green Bay, WI 54302	THE EMERGENCE OF WESTERN TECHNOLOGY The second half of a two-semester sequence (the first is an introductory physical science course) that explores a variety of social and value questions related to science and technology. Utilizes a historical theme as the teaching vehicle. Extensive lecture notes provide a detailed outline of the course.
EPHRAIM, JOHN Dept. of Technology School of Applied Science and Technology East Tennessee State Univ. Johnson City, TN 37601	MAN, SOCIETY AND TECHNOLOGY A one-semester interdisciplinary treatment of the relationship of technology to society. Includes a focus on several specific themes -- ecology, energy, technological alternatives -- in addition to the general theme of cultural development as related to technological quality.
GRIGGS, FRANCIS E. Dept. of Civil Engineering Union College Schenectady, NY 12308	TECHNOLOGY IN HISTORICAL PERSPECTIVE A study of four major engineering projects and their social, political, economic, and scientific contexts. Topics include the Panama Canal, the Brooklyn Bridge, the Wright brothers, and the Apollo project, with an emphasis on those factors influencing design and construction and a feeling for system behavior.
HALL, BERT S. University of Toronto 280 Huron St.,Rm. 406 Toronto, CANADA	HISTORY OF TECHNOLOGY AND ENGINEERING A two-semester survey breaking at approximately 1750 with the Industrial Revolution, utilizing a lecture and tutorial format and covering fairly standard topics. Designed primarily to introduce engineering students to the societal contexts of technology and engineering.
HAMLETT, P. W. Dept. of Political Science Univ. of Missouri-Rolla Rolla, MO 65401	SCIENCE, TECHNOLOGY AND POLITICS The influence of science and technology on contemporary politics is the theme of this upper-level seminar designed for non-majors. Utilizes both lecture and discussion. Solid reading assignments.

HARTMAN, J. PAUL
Engineering Room 214
College of Engineering
Univ. of Central Florida
Orlando, FL 32816

ENGINEERING AND TECHNOLOGY IN HISTORY

A one-semester survey covering the sweep of history from the ancients to the space-age era. Students receive an extensive compendium, including lecture notes, graphics illustrating certain technological developments, study questions, and bibliographical suggestions.

HAZELTINE, BARRETT
Division of Engineering
Brown Universty
Providence, RI 02912

INTERMEDIATE TECHNOLOGY

Designed to consider whether appropriate technology can actually meet relevant human physical needs combined with desirable personal and social benefits. A general understanding of AT and its possible benefits is combined with a close look at the actual workings of specific technologies such as wind and water power generators, aqua-culture, and methane digesters.

HEATON, GEORGE R.
HOLLOMAN, J. HERBERT
ASHFORD, NICHOLAS S.
HILL, CHRISTOPHER T.
Center for Policy
Alternatives
Massachusetts Inst. of Tech.
W. 59-205, 201 Vassar St.
Cambridge, MA 02139

GOVERNMENT AND THE MANAGEMENT OF TECHNOLOGY

This team-taught seminar "examines the changing role of government in shaping and directing the management of technology in the civilian sector of the economy."

HINDLE, BROOKE
5214 NMHT
Smithsonian Institution
Washington, DC 20560

TECHNOLOGY IN AMERICA

The focus of this one-semester survey is on the processes of mechanization and industrialization and the social context in which they took place. Includes additional bibliographical suggestions and sample exam questions.

HOUNSHELL, DAVID
Dept. of History
University of Delaware
Newark, DE

INTRODUCTION TO THE HISTORY OF TECHNOLOGY

A thematic survey of the history of technology from roughly the middle ages to the twentieth century that utilizes Mumford's *Technics and Civilization* as an interpretive framework for understanding this history, but also the discipline itself. A thought-provoking approach.

GREAT MOMENTS IN ENGINEERING

A semester-long topical and thematic treatment of the history of engineering covering developments such as the steam engine, bridge building, industrial research

	laboratories, the assembly line, the computer, nuclear engineering, and space technology.
HOURANI, BENJAMIN Dept. of Politial Science Eastern Michigan Univ. Ypsilanti, MI 48197	POLITICS AND THE TWENTY-FIRST CENTURY An examination of politics as it relates to technology in the contemporary world and the changes that are and will have to occur as society undergoes the transition from industrialization to post-industrialization.
HYE, ALLEN E. Modern Languages Wright State University Dayton, OH 45435	THE MORAL DILEMMA OF THE SCIENTIST This quarter-length course seeks "insight into the complex, compelling character of the scientist as he/she is portrayed in modern dramatic literature. It attempts to deal with the scientist as he/she strives to know more of the world and is forced to consider the moral and philosophical implications of higher findings." Interesting readings could be utilized in a variety of non-literary courses.
JONES, W. B. Dept. of Philosophy Old Dominion University Norfolk, VA 23508	TECHNOLOGY AND THE FUTURE OF MAN Drawing upon a historical background and perspective, "the intent of this course is to foster a better understanding of the nature of technology, man's involvement with it, and of the prospects it holds for the future." The first half of the course is largely historical, while the second half, which utilizes student projects and reports, focuses on the contemporary and future world.
KING, SARAH SANDERSON Univ. of Hawaii at Manoa Dept. of Communicaion 2560 Campus Rd., Rm. 313 Honolulu, Hawaii 96822	COMMUNICATION POLICY AND PLANNING: ALTERNATIVE PERSPECTIVES Intended primarily for students planning to enter the field of communications. The focus is on alternative models in communications policy and planning, especially as they relate to differing cultures. Includes a detailed course outline and useful bibliography.
LAIRD, DAVID California State Univ. 5151 State Univ. Drive Los Angeles, CA 90032	CULTURE AND TECHNOLOGY An interdisciplinary look, primarily literary and sociological, at some of the major cultural issues confronting modern technological society, issues such as the

implications of growing complexity and specialization, the tensions between efficiency and moral, aesthetic, or religious standards of value, political questions related to attempts to control and direct technology, and the issue of technologically-induced alienation.

AMERICAN LIVES AND THE SEARCH FOR COMMUNITY
An examination of technology's impact upon the individual and his or her relationship to society and its religious, cultural, and political institutions.

LAYTON, EDWIN
Dept. of Mech. Engineering
Univerity of Minnesota
125 Mechanical Engineering
Minneapolis, MN 55455

TECHNOLOGY AND WESTERN CIVILIZATION: ANCIENT AND MEDIEVAL, RENAISSANCE TO INDUSTRIAL REVOLUTION, 19th AND 20th CENTURIES
A solid and fairly standard, year-long three-quarter sequence emphasizing the major technological topics in the history of western civilization from the ancient world to the 20th century.

LEVINSON, PAUL
Communications, Speech
and Theatre
Fairleigh Dickinson Univ.
Teaneck, NJ 07666

INTRODUCTION TO MASS MEDIA
The history of mass communications, including writing, printing, photography, telegraphy, the telephone, the phonograph, motion pictures, radio and television. Each is examined in its broader social context.

MEDIA AND PROPAGANDA
An analysis of propaganda as related to technology both generally and in relationship to specific media.

LEWIS, W. DAVID
History Department
Auburn University
7030 Haley Center
Auburn, AL 36849

TECHNOLOGY AND CIVILIZATION
This solid and standard, 3-quarter length, lecture course covers the central topics in the history of technology from the ancient world to the present. Slide illustrated.

SCIENCE FICTION AS INTELLECTUAL HISTORY
An examination of classic science fiction novels as historical documents that reveal the political, social, intellectual, economic, and military circumstances of the period in which they were writtten. Authors studied include Mary Shelley, Jules Verne, H. G. Wells, Aldous Huxley, Arthur C. Clarke, and Colin Wilson.

LIMPER, PETER F. BECKER, PHILIP M. Christian Brothers Coll. 650 East Parkway South Memphis, TN 38104	SOCIETY AND TECHNOLOGY A study of certain aspects of the relationship between technology and society, focusing in particular on such topics as resources, the industrial society and work, and information and communications technologies.
LINDAUER, GEORGE C. Speed Scientific School Univ. of Louisville Belknap Campus Louisville, KY 40292	TECHNOLOGY AND SOCIETY This course covers a range of topics including the historical development of technology, contemporary questions of population, energy and the environment, ethical issues surrounding the use of technology, future shock, and technology assessment. Utilizes a variety of simulations, film and video-tape-based discussions, and debate techniques to involve the students.
LINTEREUR, GARY E. Northern Illinois Univ. Coll. of Professional Studies Dept. of Industry and Technology DeKalb, IL 60115	TECHNOLOGY AND CULTURAL RELEVANCE The relationship of technology to society and values in a future context. Topics include transportation, work and leisure, education, genetics, the city, energy, personal relationships, and technology forecasting.
LUNENFELD, MARVIN Dept. of History State University College Fredonia, NY 14063	INTRODUCTION TO THE HISTORY OF TECHNOLOGY A departmentally team-taught, one-semester survey of technology in world history. Selected topical coverage.
MARK, ROBERT DAVIS, MICHAEL School of Architecture Princeton University Princeton, NJ 08544	STRUCTURE IN ARCHITECTURAL HISTORY A seminar (team-taught by a structural research engineer and an architectural historian) that seeks to understand the relationships between structural technology and the architecture of large historical buildings and monuments.
MERRIAM, GEORGE H. Department of History Fitchburg State College Fitchburg, MA 01420	MAN/TECHNOLOGY/SOCIETY A semester-length survey of the relationship of technology to society that takes a largely historical approach. The course is divided into roughly equal quarters devoted to ancient and medieval technology, the Industrial Revolution in Britain and America, the response to the American Industrial Revolution, and current problems of technology in society.

MERRITT, RAYMOND H. Minneapolis Coll. of Arts and Design 133 East 25th Street Minneapolis, MN 55404	SOCIAL HISTORY OF AMERICAN TECHNOLOGY A two-semester survey of American technology in its social setting; includes a partial listing of slides used to illustrate lectures.
MEZA, PEDRO THOMAS Queensboro Comm. College Springfield Blvd. and L.I. Expressway Bayside, NY 11364	HISTORY AND TECHNOLOGY This one-semester course covers the period from the ancient world to the 20th century, but the bulk of the survey focuses on the Industrial Revolution. Includes sample examinations.
MILLER, DANIEL A. Chairman, Div. of Social Sciences Indiana State Univ., Evansville 8600 Univ. Boulevard Evansville, IN 47712	THE HISTORY OF TECHNOLOGY This semester-long survey of technology in western civilization from ancient times concentrates on the 19th and 20th centuries, especially in the United States. Sample exam questions are included.
MORRIS, R. J. Dept. of General Science Oregon State Universty Corvallis, OR 97331	TECHNOLOGY AND CHANGE A combination of historical and contemporary topics are examined to show the relationship of economic, political, and social contexts to technological developments.
MOSS, MITCHELL Grad. School Public Admin. New York University 4 Washington Square, North New York, NY 10003	TECHNOLOGICAL CHANGE AND URBAN POLICY Public policy and technological change are examined in the urban context, especially as they are related to communications technology. Useful readings.
	COMMUNICATIONS, TECHNOLOGY AND CITIES An in-depth look at communications technologies and their impact on uban development and function. Also contains similarly valuable readings as above.
NADLER, GERALD Indus. Engineering Dept. 447 Mech. Engineering Bldg. University of Wisconsin 1513 University Avenue Madison, WI 53706	SOCIOTECHNICAL DESIGN CONCEPTS A project-oriented course designed to teach non-engineers about technological planning and design concepts.

OCHS, KATHLEEN H. Humanities and Social Sciences Department Colorado School of Mines Golden, CO 80401	ENGINEERING IN WESTERN CIVILIZATION Technological themes and development from Paleolithic stone tools to 20th-century scientific-based technology are briefly covered in this one-semester survey. A well-balanced treatment of topics given the length of the course.
PUNDSACK, VICTORIA College of Applied Science Univ. of Cincinnati #103 M. L. Cincinnati, OH 45220	TECHNOLOGY AND SOCIETY This 10-week course is divided into two halves, the first historical and the second contemporary with a focus on human values questions. The historical focus is American, while the values-oriented segment includes questions of an international scope such as computers, resources and nature, world peace, and human freedom. Includes sample study questions and paper topics.
PURSELL, CARROLL Dept. of History Univ. of California Santa Barbara Santa Barbara, CA 93106	THE MACHINE IN AMERICA A two-semester survey of American technology breaking at approximately 1900 with a balanced selection of topics covered.
PYTLIK, EDWARD C. Coll. of Human Resources and Education West Virginia University Morgantown, WV 26506	TECHNOLOGY: ITS HISTORY AND DEVELOPMENT "A study of the major technical periods in history and the inter-relationship of technological development to the social/cultural milieu." Specific themes covered include: man as toolmaker, manufacturing and production, mining and metallurgy, food production, energy production, and developments in construction, transportation and communication.
	TECHNOLOGY IN HISTORY An upper-level course formulated around the "Connections" series but supplemented by additional texts that focus on selected inventions and innovations.
RASMUSSEN, J. P. California State Coll., Stanislaus Turlock, CA 95380	THE TECHNOLOGICAL SOCIETY "An interdisciplinary analysis of the social and ecological crisis caused by the exponential growth of science and technology. The issues -- population, energy, alienation, pollution, etc. -- are examined on the global, national, and local levels."

ROMER, ALFRED St. Lawrence University Canton, NY 13617	THE HISTORY OF TECHNOLOGY A specifically focused treatment of technological development for earliest man concentrating on the technologies of fire and structures with some additional emphasis on the early domestication of cereal grains and farm animals. Based on a detailed text of lecture notes by the instructor. Includes exam questions and paper topics.
ROSE, MARK H. Program in Science, Technology and Society Michigan Technological University Houghton, MI 49931	SOCIETY AND TECHNOLOGY: IMPACTS AND INTERRELATIONSHIPS, 1890-1980 The historical relationship of technology and American society with the growth of transportation facilities and urban centers as focal points, especially as they have influenced family patterns and housing. Sample exams included. AMERICAN BUSINESS AND TECHNOLOGY SINCE 1890 The organization, routines, techniques, market strategies, and innovations of American business are the focus of this quarter-length course. In addition, the impact of business decisions and technologies upon urban development, educational and political institutions, labor, and the family are examined.
SEGAL, HOWARD P. Burns Park Condo 1531 Packard Rd., #14 Ann Arbor, MI 48104	AMERICAN TECHNOLOGY AND SOCIETY: HISTORICAL PERSPECTIVES A one-semester survey of American technology focusing primarily on the Industrial Revolution, its societal impact, and the resultant response. LITERATURE AND TECHNOLOGY An examination of literary responses to technology, particularly since the Industrial Revolution, focusing on such themes as worker alienation, the impact of machine production, and tecnological utopianism. Includes sample theme topics and the final exam.
SELL, NANCY I.S. No. 409 University of Wisconsin-Green Bay Green Bay, WI 54302	TECHNOLOGY AND SOCIETY An essay summary of an interdisciplinary course that analyzes through a lecture/discussion format both the scientific basis and the values implications of

	topics including: industrial technology, energy, biotechnology, computers, and food technology. The final portion of the course is devoted to learning about the techniques and actually conducting a technology assessment. Sample exam questions available.
SIMON, ROGER Department of History Lehigh University Bethlehem, PA 18015	THE MACHINE IN AMERICA A solid one-semester survey of the history of American technology utilizing texts suitable for the introductory level, but also sophisticated enough for upper-level students.
SINCLAIR, BRUCE Inst. for History and Philosophy of Science University of Toronto Toronto, CANADA M5S 1A1	MAN AND MACHINES IN AMERICAN HISTORY A two-semester seminar treatment with a good list of readings for each of the standard topics.
SUSSMAN, M. V. Tufts University Medford, MA 02155	TECHNOLOGY AS CULTURE "An examination of the cultural and political effects of technology," as well as "the cultural factors that accelerated the exploitation and growth of technology in Western society." A historical background is followed by a comparison of technologically simple and advanced societies.
STAFF Univ. of British Columbia Dept. of Chem. Engineering 2216 Main Hall Vancouver, B.C. CANADA V6T 1W5	TECHNOLOGY AND SOCIETY A 25-week long, team-taught course dealing with the influence of technology upon various aspects of society. 6-week modules cover: engineering and social purposes, energy options, work, and agricultural and industrial development. Lecture/discussion format; includes study/essay questions for each module.
WILSON, ERIKA SCHELLIN, PETE California State Univ. 5151 State University Dr. Los Angeles, CA 90032	ART, RELIGION AND TECHNOLOGY "An interdisciplinary study of religious and aesthetic values as they have been affected by technological developments."

WILSON, FRED L. College of General Studies One Lomb Memorial Dr. R.I.T. P. O. Box 9887 Rochester, NY 14623	SOCIAL CONSEQUENCES OF TECHNOLOGY Following a brief historical analysis of technological development since the Industrial Revolution in which technology is viewed as "the driving force of change," the course takes up a number of contemporary technologically related cases -- capitalism, class struggle, business cycles, poverty, the arms race, cities, and resources. The course ends with a section on suggestions for problem-solving. Detailed study questions for each topic are included.
WOOD, P. B. Inst. for History and Philosophy of Science and Technology Univ. of Toronto Toronto, Ontario CANADA M5S 1A1	TECHNOLOGY, ENGINEERING AND SOCIETY This semester-length course focuses on three major themes in the history of science, technology, and engineering from 1750 to 1945: the relationship of science and technology, the development of industrial research, and the changing social role of the engineer.
YORK, NEIL L. Dept. of American Studies 133 FOB Brigham Young University Provo, UT 84602	THE MACHINE IN AMERICA The machine as a cultural phenomenon, "as a builder and destroyer of values," is the primary theme of this one-semester survey of American technology. The focus of the course is on the late nineteenth and twentieth centuries.